AEROSPACE REPORT NO.
ATR-72(7312)-1, VOL II

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NASA Payload Data Book
Payload Analysis for Space Shuttle Applications (Study 2.2) Final Report,
Volume II

Prepared by
ADVANCED VEHICLE SYSTEMS DIRECTORATE
Systems Planning Division

31 JULY 1972

Prepared for OFFICE OF SPACE SCIENCE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D. C.

Contract No. NASW-2301

Systems Engineering Operations
THE AEROSPACE CORPORATION

Report No.
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NASA PAYLOAD DATA BOOK

PAYLOAD ANALYSIS FOR SPACE SHUTTLE APPLICATIONS (Study 2.2) FINAL REPORT, VOLUME II

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NASA PAYLOAD DATA BOOK

PAYLOAD ANALYSIS FOR SPACE SHUTTLE APPLICATIONS (Study 2.2)
FINAL REPORT, VOLUME II

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ACKNOWLEDGEMENTS

The NASA Payload Data Book has been prepared by T. Shiokari and A. A. Hanson. The document is based on NASA input data furnished by the NASA cognizant engineers and AAD through Dr. Rodney Johnson, NASA Technical Assistant for Shuttle Operations.

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FOREWORD

This document is part of a 2-volume Aerospace Corporation final report on Study 2.2, Payload Analysis for Space Shuttle Applications, NASA Contract No. NASW-2301. The report is comprised of the following volumes:

Volume IA:	Executive Summary
Volume I:	Payload Design Guidelines
Volume II:	NASA Payload Data Book

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CONTENTS

I. INTRODUCTION

This document is a collection of data describing the individual NASA payloads included in the June 1972 Mission Model.[1] The document represents a complete reissue of the original Payload Data Book.[2] The payload data sheets are revised and updated versions of the payload data previously published, extensive changes in payload data and the mission model having precluded a simple revision of the volume as had been originally planned. Non-NASA payloads could not be included in this revised document because the non-NASA mission model was not available in time for publication.

Minor changes have been made in the format of the data sheets. One such change reports payload data in the International System of Units (SI), as well as in the customary units of measurement, with respect to all calculations originating with this study.

The NASA payload data descriptions documented herein are the result of a joint NASA/Aerospace effort. NASA was asked to review the original document and to supply updated information, particularly with regard to mission objectives and mission equipment. This information was supplied by NASA in the form of modified payload data sheets or, in some cases, new versions of the original sheets. Aerospace also visited NASA Headquarters in May 1972 to obtain current payload information from responsible engineers in the form of study reports, if available, and comments regarding the new mission model.

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1 See Ref. 1

2 See Ref. 2

Aerospace has reviewed these reports, data sheets, and comments, and has supplied additional and updated inputs as appropriate in the related subsystem areas. Inputs were received from several support areas within the company. The entire effort was coordinated through a series of meetings and telephone conferences with Dr. R. W. Johnson, Technical Director for Study 2.2, and other cognizant NASA personnel.

The data presented in this document have been obtained from many sources, including reports to and by the National Academy of Sciences, NASA reports, the open literature, and NASA contractor reports, as well as the material supplied by NASA Headquarters. Study reports published by contractors and various agencies were examined and are referenced in the appropriate payload data sheets. (See Section XIII for a listing of references.)

The scope of effort under the present contract did not allow for preliminary designs to define the detailed characteristics of each payload. Most of the data were derived, therefore, from contractor study reports, statistical studies based on historical data, and knowledge of similar and current systems. For these reasons the weight and volume statements included with the payload data are based on the use of current expendable launch vehicles and payloads. Lack of data prevented consideration of modular design concepts and other cost reduction factors that may affect payload design for the Space Shuttle program. The user of this document is therefore cautioned to consider the supporting subsystem characteristics as approximate and tentative, with the understanding that they should be revised for each specific payload as the mission requirements become better defined and after preliminary design effort has been completed.

This document should be regarded as a current Payload Data Book which will require updating as the payloads become better defined, requirements are modified, and mission model changes occur. It is recommended that the document be used as a baseline from which payload tradeoff

studies can be conducted. Within the constraints of present knowledge, this set of data represents payload concepts that can fulfill the NASA mission objectives as presently defined.

In general, it was assumed that the payloads would be launched as expendables, although it should be realized that some of the payloads, such as the Space Station and the Sortie, are reusable. For these missions the payload characteristics are based on the concepts of maintenance, replacement, resupply, and retrieval, and the relaxation of payload weight and size constraints attributable to the use of the Shuttle.

For the planetary missions the payload weights and characteristics quoted in this document include allowances for propulsive units whenever solar electric propulsion is recommended in preference to the ballistic approach. These missions assume that an upper stage is available for injection into transfer trajectory.

It is important to note that an attempt has been made in this investigation to examine each payload without associating it with a specific launch vehicle, although it is obvious that in many cases specific launch vehicles were in mind when the original weight and size estimates were made.

II. DEFINITIONS OF TERMS AND ABBREVIATIONS

Some of the terms used in this document have a variety of meanings within the aerospace community. The following terms require definition and explanation:

SYSTEM EXPECTED LIFETIME is the time period that the system is expected to be operational in order to achieve the mission objectives. During this time, resupply, maintenance, or refurbishment of the satellites may occur, or the satellites may be replaced.

SATELLITE MEAN MISSION DURATION is the expected or mean mission time a satellite will perform satisfactorily without failure, considering all factors (for example, expendables). Mathematically, Mean Mission Duration (MMD) is defined as the area under the reliability curve from time zero to the time of expendable depletion, which is referred to as the truncation time.

CHARACTERISTIC VELOCITY is the arithmetic sum of the 185 km (100 nmi) circular parking orbit velocity and the Hohmann transfer velocity to mission orbit, but excluding inclination effects on launch vehicle requirements to reach the 185 km (100 nmi) orbit for low earth orbit missions. The velocity for this circular parking orbit is 7,797 m/sec (25,581 ft/sec).*

SATELLITE WEIGHT is the weight of the satellite at the time it reaches its mission orbit. It does not include the weight of fairings, adapters, dispensers, or upper stage.

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* In the case of high earth orbit, such as synchronous missions, the characteristic velocity includes inclination effects by assuming payload injection into a 28.5° inclination at 185 km (100 nmi) circular orbit before transfer to the mission orbit.

MISSION EQUIPMENT is the equipment that is mission peculiar, or the part of the satellite that is directly related to the accomplishment of the mission objectives. The terms Mission Equipment and Experiments are synonymous, if the structure that is required solely to support the experiments is included in experiments.

SUPPORTING SUBSYSTEMS are those subsystems such as structures, avionics, electrical power, propulsion, stabilization, and attitude control that are required to support the mission equipment for a viable orbiting system. In the total system, when the satellite is associated with a specified launch vehicle, apogee kick motors (if required) would normally be included as part of the supporting subsystems since they are often an integral part of the satellite and perform a dual function. The requirement in this document, however, is to examine each payload with the emphasis on orbital performance and without considering the relationship of a particular satellite to a specific launch vehicle. For this reason kick motor requirements are not included in the weight estimates. Second-level studies, which would include the launch vehicle, of course would involve consideration of the kick motor requirements.

PAYLOAD is a collective word used to describe the total operating entity that is launched into orbit. It includes mission equipment (experiments) and supporting subsystems (spacecraft), but excludes launch vehicle-related elements (such as the adapter or the fairing) that are non-functional in orbit. For a satellite system the payload consists of the satellite. For a planetary system the payload consists of the probe, orbiter, or lander.

Following is a list of abbreviations used in the Payload Data Sheets:

ACS	Attitude Control System
bps	bits per second
bpd	bits per day
CMG	Control Moment Gyro
dbm	decibels above 1 milliwatt
FOV	Field of View
LEO	Low Earth Orbit
NA	Not Applicable
OA	NASA Office of Applications
OAST	NASA Office of Aeronautics and Space Technology
OMSF	NASA Office of Manned Space Flight
OSS	NASA Office of Space Science
PIA	Pointing Instrument Assembly
RTG	Radiosotope Thermoelectric Generator
SEP	Solar Electric Propulsion
sr	steradian
T/M	Telemetry
UHF	Ultra High Frequency
USB	Unified S-Band NASA Tracking, Telemetry, and Control System
UV	Ultra-violet
VHF	Very High Frequency

III. MISSION MODEL KEY

The salient features of the June 1972 NASA Mission Model[1] are juxtaposed with the corresponding payload codes in the tables that follow. The payload subtitles separate key mission model payloads according to orbits, payload weights, etc. This delineation, which will be noted particularly in the Explorer, the Gravity and Relativity, and the Environmental Perturbation satellites, has been established in order to provide consistent information concerning each payload described in the document. The tables also call out code numbers for the payloads treated in the several sections that make up the document.

Missions that are not included in this Payload Data Book are those with launch dates prior to 1979. Only those payloads scheduled within the 1979-90 launch period are included.

Payload information on the 1972 Lunar Exploration Supplement was not available in time for this publication. Lunar mission data that is included in this volume is updated information from the 1971 NASA Payload Data Book[2] prepared by The Aerospace Corporation.

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1 See Ref. 1

2 See Ref. 2

Correlation, NASA Mission Model to NASA Payload Data

ASTRONOMY (Agency: OSS)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
<u>Automated Spacecraft</u>				
Explorers	X	X	LEO	NA2-1
			Synchronous	NA2-2
Orbiting Solar Observatory	X			
High Energy Astronomy Observatory	X			
<u>Man-Tended Observatories</u>				
High Energy Astronomy Observatory		X		NA2-3
Revisits		X		NA2-4
Large Space Telescope		X		NA2-5
Revisits		X		NA2-6
Large Solar Observatory		X		NA2-7
Revisits		X		NA2-8
Large High Energy Telescope, X-ray		X		NA2-9
Revisits		X		NA2-10
Radio Astronomy Observatory		X		NA2-11
<u>Sorties</u>				
Astronomy and Physics Observations		X		NA2-12

Correlation, NASA Mission Model to NASA Payload Data

SPACE PHYSICS (Agency: OSS)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Automated Spacecraft				
Explorers	X	X	Upper Atmos.	NP2-13
			Medium Alt.	NP2-14
			High Alt.	NP2-15
Gravity and Relativity Satellites		X	LEO	NP2-16
			Solar	NP2-17
Environment Perturbation Satellites		X	Mission A	NP2-18
			Mission B	NP2-19
Heliocentric and Interstellar Spacecraft		X		NP2-20
Space Station Research and Application Modules				
Physics Laboratories		X		NP2-21

Correlation, NASA Mission Model to NASA Payload Data

PLANETARY EXPLORATION (Agency: OSS)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Mars Viking	X	X		NU2-22
Mars Rover		X		NU2-23
Venus Mercury Flyby	X			
Venus Pioneer	X	X		NU2-24
Venus Radar Mapper		X		NU2-25
Venus Large Lander		X		NU2-26
Helios	X			
Mercury Orbiter		X		NU2-27
Pioneer-Jupiter Flyby	X			
Pioneer-Jupiter Orbiter	X	X		NU2-28
Mariner-Jupiter/Saturn Flyby	X			
Mariner-Jupiter/Uranus Flyby		X		NU2-29
Pioneer-Jupiter Probe		X		NU2-30
Pioneer-Saturn Probe		X		NU2-31
Mariner-Jupiter Orbiter		X		NU2-32
Uranus Probe/Nepture Flyby		X		NU2-33
Mariner-Saturn Orbiter		X		NU2-34
Encke Slow Flyby		X		NU2-35
Encke Rendezvous		X		NU2-36
Asteroid Rendezvous		X		NU2-37

Correlation, NASA Mission Model to NASA Payload Data

EARTH OBSERVATIONS, EARTH AND OCEAN PHYSICS (Agency: OA)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Automated Spacecraft - Earth Observations				
Research & Development				
Earth Resources Technology Satellite	X			
NIMBUS	X			
Earth Observatory Satellite	X	X		NE2-38
Sync. Earth Observatory Satellite		X		NE2-39
Systems Demonstration				
TIROS	X	X		NE2-40
Sync. Met. Satellite	X	X		NE2-41
Earth Resources Satellite		X		NE2-42
Sync. Earth Observ. Satellite - Prototype		X		NE2-43
Sorties - Earth Observations				
Earth Observation Lab.		X		NE2-44
Automated Spacecraft - Earth and Ocean Physics				
GEOS	X			
LAGEOS	X			
GEOPAUSE		X		NE2-45

Correlation, NASA Mission Model to NASA Payload Data

COMMUNICATIONS AND NAVIGATION (Agency: OA)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Automated Spacecraft				
Research & Development				
Applications Technology Satellite	X	X		NC2-46
Cooperative Applications Satellite	X			
Small Applications Technology Satellite	X	X	Synchronous	NC2-47
			Polar	NC2-48
Systems Demonstration				
Tracking and Data Relay Satellite	X	X		NC2-49
Disaster Warning Satellite	X	X		NC2-50
System Test Satellites		X		NC2-51
Sorties				
Communications/Navigation Exp.		X		NC2-52
Communications/Navigation Lab.		X		NC2-53
Space Station Research and Application Modules				
Communications/Navigation Lab.		X		NC2-54

Correlation, NASA Mission Model to NASA Payload Data

LIFE SCIENCE (Agency: OMSF)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Automated Spacecraft				
Bio-Research Module	X	X		NB2-55
Teleoperator		X		NB2-56
Sorties				
Mini 7-Day Module		X		NB2-57
Mini 30-Day Module		X		NB2-58
Space Station Research and Application Modules				
Mini 30-Day Module		X		NB2-59
Station Laboratory Experiments		X		NB2-60

Correlation, NASA Mission Model to NASA Payload Data

SPACE TECHNOLOGY AND MATERIAL SCIENCE (Agency: OAST)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
<u>Automated Spacecraft</u>				
Meteoroid and Exposure Module	X	X		NT2-61
<u>Sorties</u>				
Material Science Experiments		X		NT2-62
Advanced Technology Experiments		X		NT2-63
<u>Space Station Research and Application Modules</u>				
Technology and Material Science Lab.		X		NT2-64

Correlation, NASA Mission Model to NASA Payload Data

SKYLAB, INTERNATIONAL RENDEZVOUS AND DOCKING MISSION AND SPACE STATION (Agency: OMSF)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Skylab				
Orbital Workshop	X			
Revisits	X			
International Rendezvous and Docking Mission	X			
Space Station				
Station Modules		X	Crew Ops.	NS2-65
			Power/Subsystems	NS2-66
			General Purpose Lab.	NS2-67
Crew/Operations Logistics		X		NS2-68

Correlation, NASA Mission Model to NASA Payload Data

LUNAR EXPLORATION - SUPPLEMENT (Agency: OMSF)

Mission Model			Payload Data - 1979-90	
Title	1973-78	1979-90	Subtitle	Code
Payload and Crew Launch *		X		
Payload and Crew Return *		X		
Tugs or Propellant *		X		
Lunar Landing Tug (LLT) **				NLU-1
Cargo Module **				NLU-2
Crew Rotation Module **				NLU-3
Orbiting Lunar Station **				NLU-4
Lunar Surface Base **				NLU-5

* Data on these payloads are not included because definition studies have not been accomplished.

** These payloads from the 1971 Payload Data Book are included for completeness.

IV. Astronomy

PAYLOAD DATA SHEET

TITLE: Explorer - LEO

AGENCY: NASA/OSS

CODE: NA2-1

PROGRAM: Astronomy

COGNIZANT ENGINEER: L. Dondey

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Investigation of celestial sources radiating in the X-ray, gamma ray, ultra-violet, and other spectral regions both inside and outside of our galaxy.

Spacecraft Description: SAS-C satellite

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 550 (297)/550 (297)/28.5°

Launch Window: ________ days

Initial Launch Date: 1973 yr

No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ________ %

Characteristic Velocity: 8,006 m/sec (26,265 ft/sec)

Satellite Weight: 169 kg (373 lb)

Satellite Launch Dimensions: (diam) 0.8 m (2.6 ft) (length) 1.9 m (6.2 ft) (vol) 0.9 m^3 (32.9 ft^3)

General Comments: See Ref. 3

MISSION EQUIPMENT Code NA2-1

Weight: 77.6 kg (171 lb) Power: 20 W

Type of Experiment(s): To measure the X-ray emission of discrete, extra-galactic sources, to monitor the intensity and spectra of galactic X-ray sources, and to monitor the X-ray intensity of Scorpio.

Purpose of Experiment(s): X-ray astronomy with the aim of elucidating the physical processes involved in the generation of X-rays by celestial bodies, the role of X-ray sources in the evolution of the stars and galaxies, and the nature of the X-ray background and its attenuation by interstellar matter.

Type of Sensor(s): Optical, X-ray, gamma ray sensors; collimators and counters

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Minimum contamination

Data Processing and Transmission Requirements: 10^3 bps

Attitude Control and Pointing Accuracy Requirements: 10 arc sec pointing determination accuracy and stability, 0.3 arc sec/sec drift rate

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA2-1

Unique Structural Requirements: Endo type

Environmental Control Requirements: Primarily passive, with several small heaters selectively placed

Guidance and Navigation Requirements: Point spin axis over 2π sr

Propulsive Requirements: None

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: Momentum wheel, magnetic torquers; magnetometers

Pointing Accuracy: 10 arc seconds Pointing Direction: 2π steradians

Tracking, Telemetry and Command Requirements: Programmable T/M; redundant T/M transmitters; one VHF and one S-band. Use NASA standard PCM command subsystem.

Antennas: 4 command and T/M; crossed dipoles (independent)

Computers: Attitude control Commands: Real time or delayed

Type of Electrical Power System: Solar array (paddles) and battery

Average Power: 40 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE

Code NA2-1

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

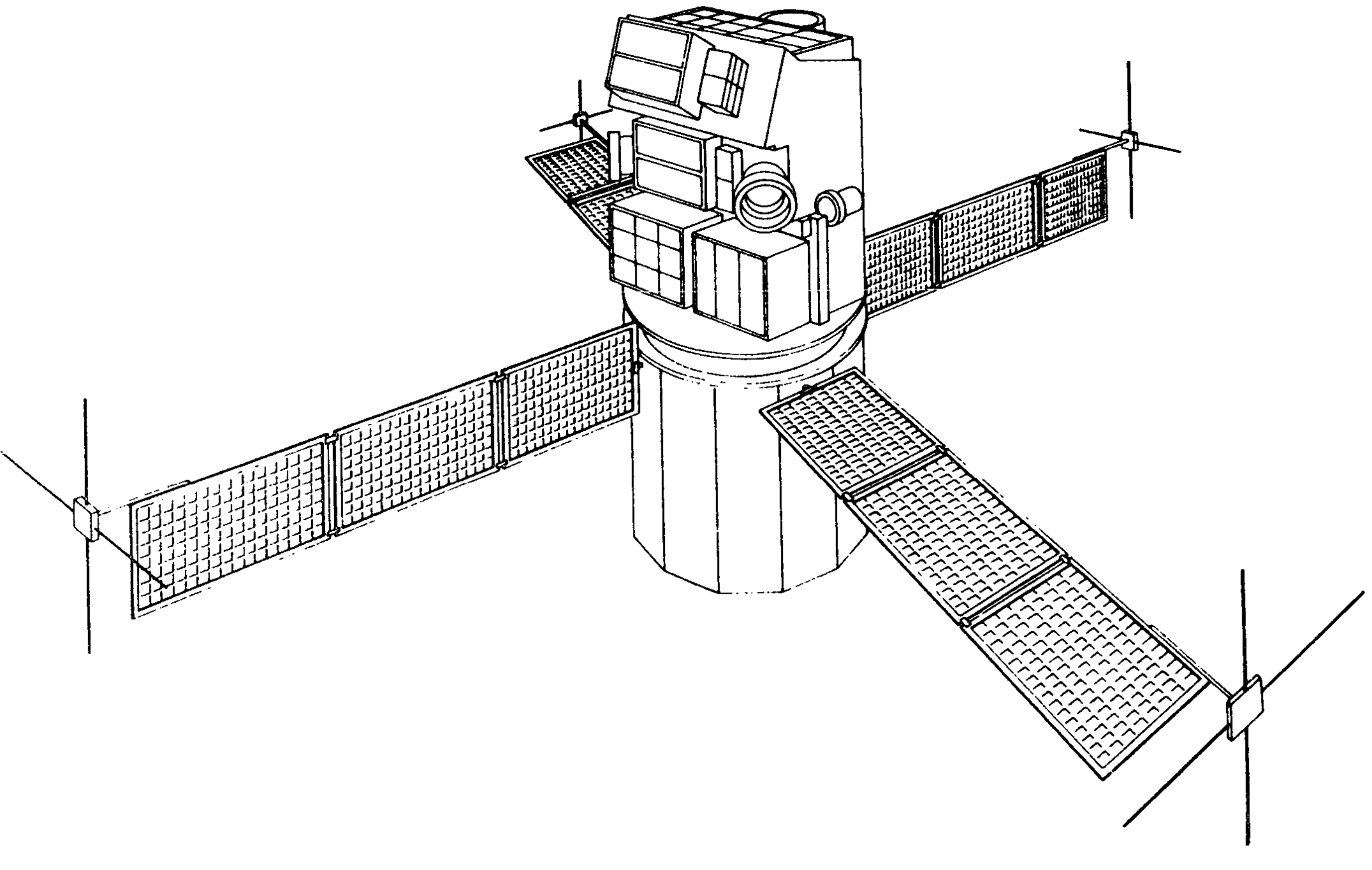
Spacecraft can be retrieved and refurbished.

WEIGHTS

Code NA2-1

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			30.5	(67.1)
Environmental Control			3.2	(7.0)
Guidance, Navigation, Stabilization			-	-
Propulsion Propellant Subsystem Dry			-	-
Attitude Control			13.8	(30.4)
Telemetry, Tracking, Command			12.8	(28.2)
Electrical, Solar Cells Batteries Conversion Conditioning Distribution			31.5	(69.5)
Mission Equipment			77.6	(171.0)
Total Weight			169.4	(373.2)
Adapter			8.7	(19.1)
Launch Weight			178.1	(392.3)

Comments: ____________



Artist's Conception of SAS-C

PAYLOAD DATA SHEET

TITLE: Explorer - Sync AGENCY: NASA/OSS

CODE: NA2-2

PROGRAM: Astronomy COGNIZANT ENGINEER: L. Dondey

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Investigation of celestial sources radiating in the X-ray, gamma ray, ultra-violet, and other spectral regions both inside and outside of our galaxy.

Spacecraft Description: SAS-C satellite

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,800 (19,323)/ 35,800 (19,323)/28.5° *

Launch Window: ______ days

Initial Launch Date: 1973 yr No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 11,738 m/sec (38,510 ft/sec)

Satellite Weight: 169 kg (373 lb)

Satellite Launch Dimensions: (diam) 0.8 m (2.6 ft) (length) 1.9 m (6.2 ft) (vol) $0.9\ m^3$ ($32.9\ ft^3$)

General Comments: See Ref. 3

* The orbit is the basic difference between this satellite and Explorer - LEO, NA2-1.

MISSION EQUIPMENT Code NA2-2

Weight: 77.6 kg (171 lb) Power: 20 W

Type of Experiment(s): To measure the X-ray emission of discrete, extra-galactic sources, to monitor the intensity and spectra of galactic X-ray sources, and to monitor the X-ray intensity of Scorpio.

Purpose of Experiment(s): X-ray astronomy with the aim of elucidating the physical processes involved in the generation of X-rays by celestial bodies, the role of X-ray sources in the evolution of the stars and galaxies, and the nature of the X-ray background and its attenuation by interstellar matter.

Type of Sensor(s): Optical, X-ray, and gamma ray sensors; collimators and counters

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Minimum contamination

Data Processing and Transmission Requirements: 10^3 bps

Attitude Control and Pointing Accuracy Requirements: 10 arc sec pointing determination accuracy and stability, 0.3 arc sec/sec drift rate

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA 2-2

Unique Structural Requirements: Endo type

Environmental Control Requirements: Primarily passive, with several small heaters selectively placed

Guidance and Navigation Requirements: Point spin axis over 2π sr

Propulsive Requirements: None

Type Propellant: ____ Thrust: ____

Orbit Adjust: ____ Total Impulse: ____ kg-sec (____ lb-sec)

Apogee Kick Motor: ____

Attitude Control: Momentum wheel, magnetic torquers; magnetometers

Pointing Accuracy: 10 arc seconds Pointing Direction: 2π steradians

Tracking, Telemetry and Command Requirements: Progammable T/M; redundant T/M transmitters; one VHF and one S-band. Use NASA standard PCM command subsystem.

Antennas: 4 command and T/M; crossed dipoles (independent)

Computers: Attitude control Commands: Real time or delayed

Type of Electrical Power System: Solar array (paddles) and battery

Average Power: 40 W Peak Power: ____

Unique Interstage/Adapter Requirements: ____

SHUTTLE INTERFACE Code NA2-2

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

Spacecraft can be retrieved and refurbished.

WEIGHTS

Code NA2-2

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			30.5	(67.1)
Environmental Control			3.2	(7.0)
Guidance, Navigation, Stabilization			-	-
Propulsion Propellant Subsystem Dry			-	-
Attitude Control			13.8	(30.4)
Telemetry, Tracking, Command			12.8	(28.2)
Electrical, Solar Cells Batteries Conversion Conditioning Distribution			31.5	(69.5)
Mission Equipment			77.6	(171.0)
Total Weight			169.4	(373.2)
Adapter			8.7	(19.1)
Launch Weight			178.1	(392.3)

Comments: ____

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PAYLOAD DATA SHEET

TITLE: High Energy Astronomy Observatory (HEAO-C) AGENCY: NASA/OSS

CODE: NA2-3

PROGRAM: Astronomy COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: ______

MISSION OBJECTIVES: Investigate detailed structure, spectra, and location of specific X-ray sources using pointed (1 arc min) spacecraft.

Spacecraft Description: Four spacecraft planned with each spacecraft having different or improved experiment sensors.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 463 ± 92 (250 ± 50)/ 463 ± 92 (250 ± 50)/28.5°

Launch Window: None days

Initial Launch Date: 1979 yr No. of Satellites in System: 1

System Expected Lifetime: 4 yr

Satellite Mean Mission Duration: 2 yr*

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,957 m/sec (26,107 ft/sec)

Satellite Weight: 8,286 kg (18,264 lb)

Satellite Launch Dimensions: (diam) 2.7 m (8.8 ft) (length) 13.1 m (43.0 ft) (vol) 74.1 m^3 (2615.3 ft^3)

General Comments: See Ref. 4

* The design goal is to provide a reliability greater than 0.95 at 1 year.

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MISSION EQUIPMENT Code NA2-3

Weight: 3,255 kg (7,175 lb)* Power: 275 W

Type of Experiment(s): X-ray

Purpose of Experiment(s): Measure X-ray energy spectrum, structure, and location.

Type of Sensor(s): High-resolution telescope, large area telescope, low energy telescope, spectrometer, and flare detectors (see attachments)

Unique Sensor Requirements and Technology Status: Requires accurate (1 arc min) pointing to stellar sources; pointing changed by command.

Environmental Requirements:

Data Processing and Transmission Requirements: Data rate 27.5 kbps Data storage 150 Mb

Attitude Control and Pointing Accuracy Requirements: 1 arc min accuracy and stability on 2 axes; 1 arc sec/sec jitter rate

Propulsion Requirements:

* Does not include 20% contingency

SUPPORTING SUBSYSTEMS Code NA2-3

Unique Structural Requirements: Design for structural stiffness. Longerons plus shear stringers. Exo.

Environmental Control Requirements: Semi-passive

Guidance and Navigation Requirements:

Propulsive Requirements: Attitude control and orbit adjust

Type Propellant: N_2H_4 Thrust: 2.3 N (0.51 lb), 12 thrusters (redundant)

Orbit Adjust: Change pointing Total Impulse: 667,000 N-sec (150,000 lb-sec)

Apogee Kick Motor: Lockheed; OAS (Orbit Adjust Stage)

Attitude Control: 3-axis, CMGs, desaturation, N_2H_4

Pointing Accuracy: 1 arc min Pointing Direction: X-ray sources

Tracking, Telemetry and Command Requirements: Use USB system; real time data rate 10^3 - 10^4 bps; playback data rate 512 kbps. Transmit RF power 20 to 37 dbm. Data storage 10^8 - 10^9 bits.

Antennas: Two 0.15 to 0.3 m (0.5 to 1 ft) diam, omni/low gain, S-band

Computers: Data compression required Commands: 256-512 (32 bits) real time and stored

Type of Electrical Power System: Solar array and battery

Average Power: 750 W Peak Power: 1250 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NA2-3

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 2

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

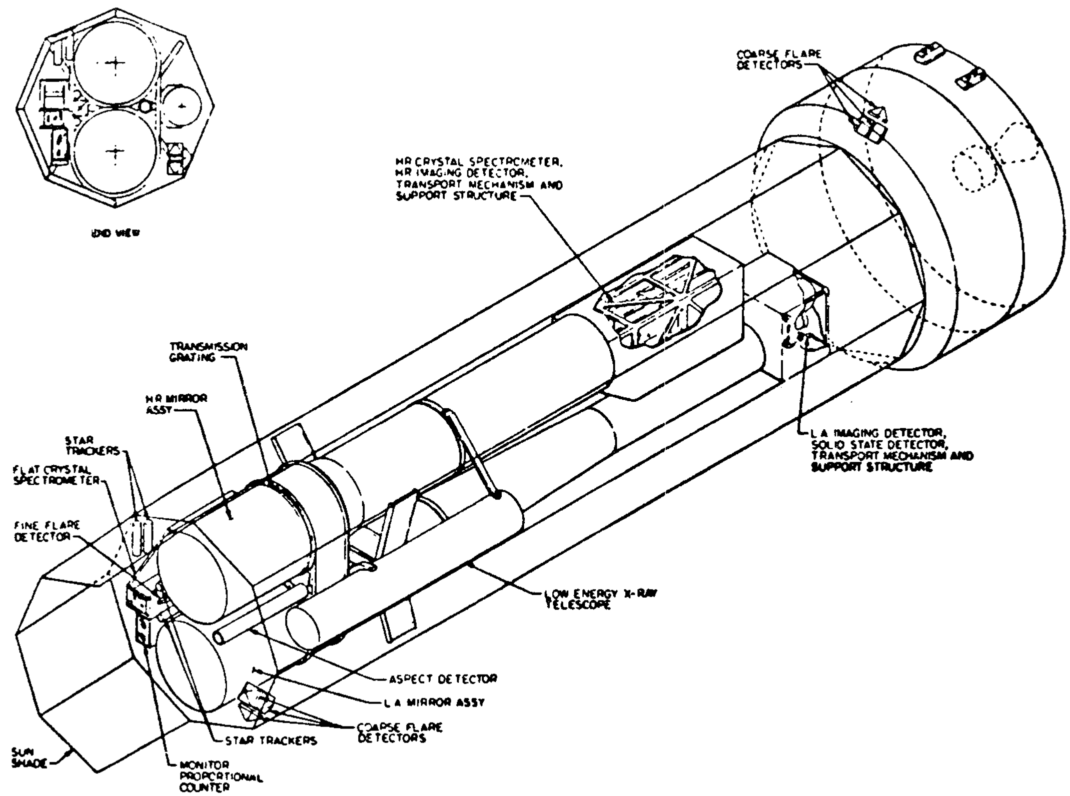
Expected Maintenance Philosophy ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

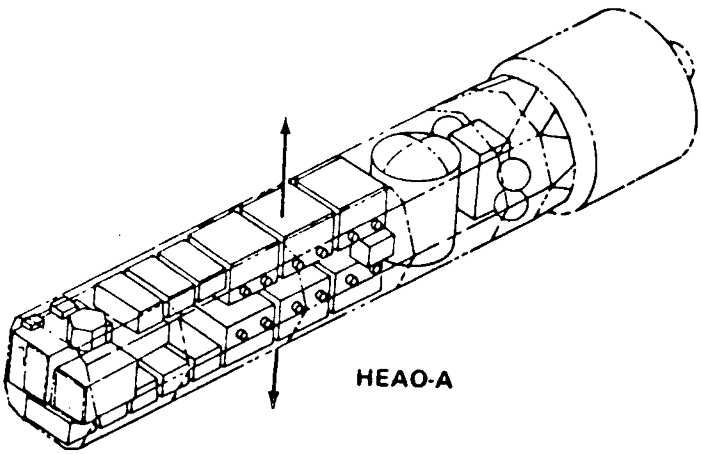
Spacecraft can be retrieved and refurbished.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			2,086	(4,598)
(Observatory)	1,531	(3,375)		
(OAS, Stripped)	555	(1,223)		
Environmental Control			230	(505)
Guidance, Navigation, Stabilization			---	---
Propulsion			---	---
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			874	(1,927)
Propellant	385	(848)		
Subsystem Dry	489	(1,079)		
Telemetry, Tracking, Command			81	(178)
Electrical, Solar Cells			445	(981)
Batteries	142	(312)		
Conversion	53	(116)		
Conditioning				
Distribution	100	(221)		
Solar Cells	151	(332)		
Mission Equipment			3,255	(7,175)
Contingency (20%)			1,315	(2,900)
Total Weight - Dry			7,900	(17,416)
Total Weight - Including Expendables			8,286	(18,264)
Adapter			96	(212)
Launch Weight			8,382	(18,476)

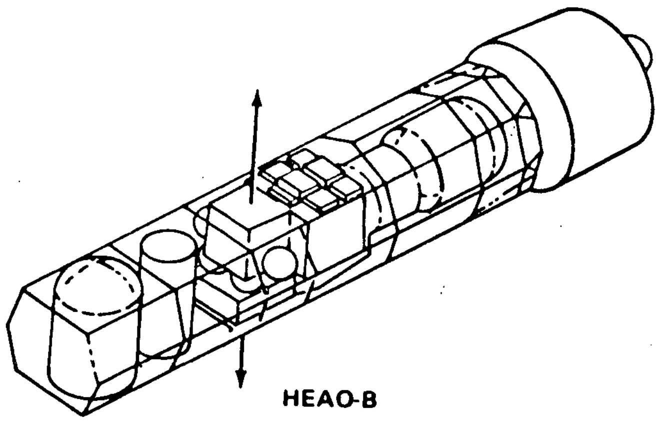
Comments: This weight estimate is for an expendable satellite. Weight for retrieval or on-orbit maintenance is not included.



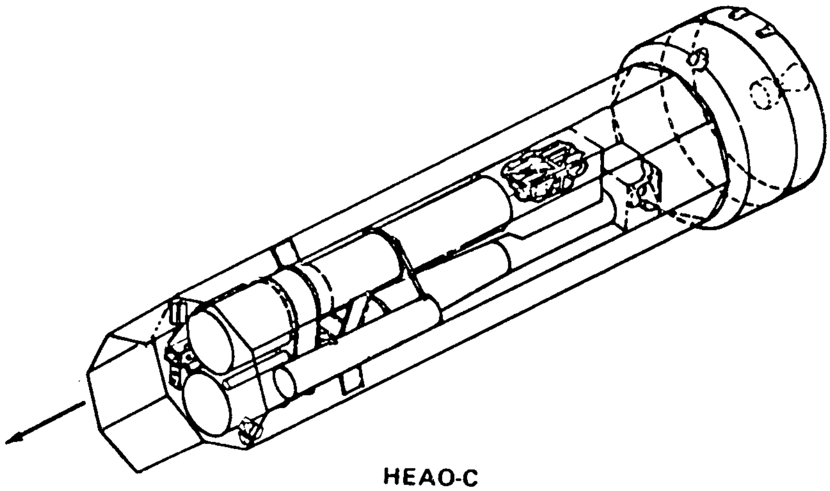
HEAO-C Baseline Spacecraft



HEAO-A



HEAO-B



HEAO-C

TYPICAL HEAO EXPERIMENT LAYOUTS
SHOWING PRINCIPAL VIEWING DIRECTIONS

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PAYLOAD DATA SHEET

TITLE: High Energy Astronomy Observatory - Revisits

AGENCY: NASA/OSS

CODE: NA2-4

PROGRAM: Astronomy

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Revisit HEAO to perform instrument change and adjustments, extend life of satellite, and resupply expendables.

Spacecraft Description: Teleoperator/Manipulator and resupply modules

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 463 ± 92 (250 ± 50)/ 463 ± 92 (250 ± 50)/28.5°

Launch Window: Rendezvous

Initial Launch Date: 1980 yr No. of Satellites in System: None

System Expected Lifetime: Resupply

Satellite Mean Mission Duration: 2 wk

Satellite Desired Availability: On demand

Characteristic Velocity: 7,957 m/sec (26,107 ft/sec)

Satellite Weight: 1,587 kg (3,500 lb)*

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 1.5 m (5.0 ft) (vol) 25.1 m^3 (885.0 ft^3)

General Comments:

* excludes Teleoperator/Manipulator

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MISSION EQUIPMENT Code NA2-4

Weight: 1,542 kg (3,400 lb) Power: 200 W

Type of Experiment(s): Resupply

Purpose of Experiment(s): Resupply

Type of Sensor(s): Replacement modules and expendables

Unique Sensor Requirements and Technology Status: Remotely change out modules and resupply expendables

Environmental Requirements: No effluents or contamination affecting optics

Data Processing and Transmission Requirements: 3 kbps

Attitude Control and Pointing Accuracy Requirements: ± 1.0 deg (nominal docking requirements)

Propulsion Requirements: Rendezvous, stationkeeping, and docking

SUPPORTING SUBSYSTEMS Code NA2-4

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Shuttle

Guidance and Navigation Requirements: Shuttle

Propulsive Requirements: Shuttle

Type Propellant: Shuttle Thrust: ______

Orbit Adjust: Shuttle Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: Shuttle

Pointing Accuracy: ± 1 deg Pointing Direction: ______

Tracking, Telemetry and Command Requirements: 3 kbps

Antennas: Shuttle

Computers: ______ Commands: ______

Type of Electrical Power System: Shuttle

Average Power: 200 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE　　　　　　　　　　　　　　　　Code NA2-4

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 2

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: N/A

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

WEIGHTS

Code NA2-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms Teleoperator/Manipulator			680*	(1500)*
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			22.7	(50)
Electrical Batteries Conversion Conditioning Distribution			22.7	(50)
Mission Equipment			1,542	(3400)
Total Weight			1,587	(3500)
Adapter			0	(0)
Launch Weight			1,587	(3500)

Comments: *Teleoperator/Manipulator is a universal tool for use by this and other payloads; not included in totals.

PAYLOAD DATA SHEET

TITLE: Large Space Telescope

AGENCY: NASA/OSS

CODE: NA2-5

PROGRAM: Astronomy

COGNIZANT ENGINEER: M. J. Aucremanne

COGNIZANT SCIENTIST: N. Roman

MISSION OBJECTIVES: Extend space astronomy capability to diffraction limited performance with 3 m (9.9 ft) diam optics; high resolution spectroscopy and imaging of planetary bodies.

Spacecraft Description: General purpose observatory, telescope computer, and high accuracy pointing capability; first unit will be arranged to accommodate optical instrumentation; free flyer

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 611 (330) / 611 (330) / 28.5^{o}

Launch Window: None days

Initial Launch Date: 1979 yr

No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: Minimum outage

Characteristic Velocity: 8,039 m/sec (26,374 ft/sec)

Satellite Weight: 8,428 kg (18,581 lb)

Satellite Launch Dimensions: (diam) 3.8 m (12.4 ft) (length) 12.7 m (41.7 ft) (vol) 142.6 m^3 (5035.8 ft^3)

General Comments: See Ref. 5

MISSION EQUIPMENT Code NA2-5

Weight: 5,505 kg (12,136 lb) Power: 262 W

Type of Experiment(s): Stellar observation

Purpose of Experiment(s): Gather video, photometric spectrographic data; stellar observations, including processes involved in locating and observing stellar objects; technology for obtaining information leading to better telescopes, instruments, and operational techniques.

Type of Sensor(s): TV, photo cameras, spectrophotometry, spectroscopy, and polarimetry

Unique Sensor Requirements and Technology Status: Fabricate, test, align, and space maintain a 305 cm (120 in) diam mirror for diffraction limited operation; achieve high pointing stability (see attached table for details)

Environmental Requirements: Minimize contamination. Shielding against radiation, thermal, and meteoroid environments.

Data Processing and Transmission Requirements: 500×10^3 bits/sec. 300×10^6 bits/orbit. 5-hour data storage.

Attitude Control and Pointing Accuracy Requirements: $\pm$ 1 arc-second on all 3 axes. 1.5 deg/min slew rate.

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA2-5

Unique Structural Requirements: Light weight, thermally stabilized telescope structure, endo type

Environmental Control Requirements: Passive system, with some use of heaters for certain components

Guidance and Navigation Requirements: Fixed head star trackers, computer star searches, sun sensors

Propulsive Requirements: Attitude control and orbit adjust

Type Propellant: Cold GN_2 Thrust: 4 thrusters (redundant) 2.3 or 45 N (0.5 or 10 lb) (dual level)

Orbit Adjust: _____ Total Impulse: _____ kg-sec (_____ lb-sec)

Apogee Kick Motor: _____

Attitude Control: 3-axis control. Control moment gyros, magnetic torquers, magnetometers

Pointing Accuracy: $\pm$ 1 arc second Pointing Direction: 2 π steradians

Tracking, Telemetry and Command Requirements: USB system, redundant communications

Antennas: 2 conical spiral antennae

Computers: _____ Commands: Storage for 5 hours of operation

Type of Electrical Power System: Solar array (paddles) and batteries

Average Power: 1462 W Peak Power: _____

Unique Interstage/Adapter Requirements: _____

SHUTTLE INTERFACE Code NA2-5

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: 1600 kg (3500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ____ hr

Requirement for Retrieval:*Yes X No ____ Desirable ____

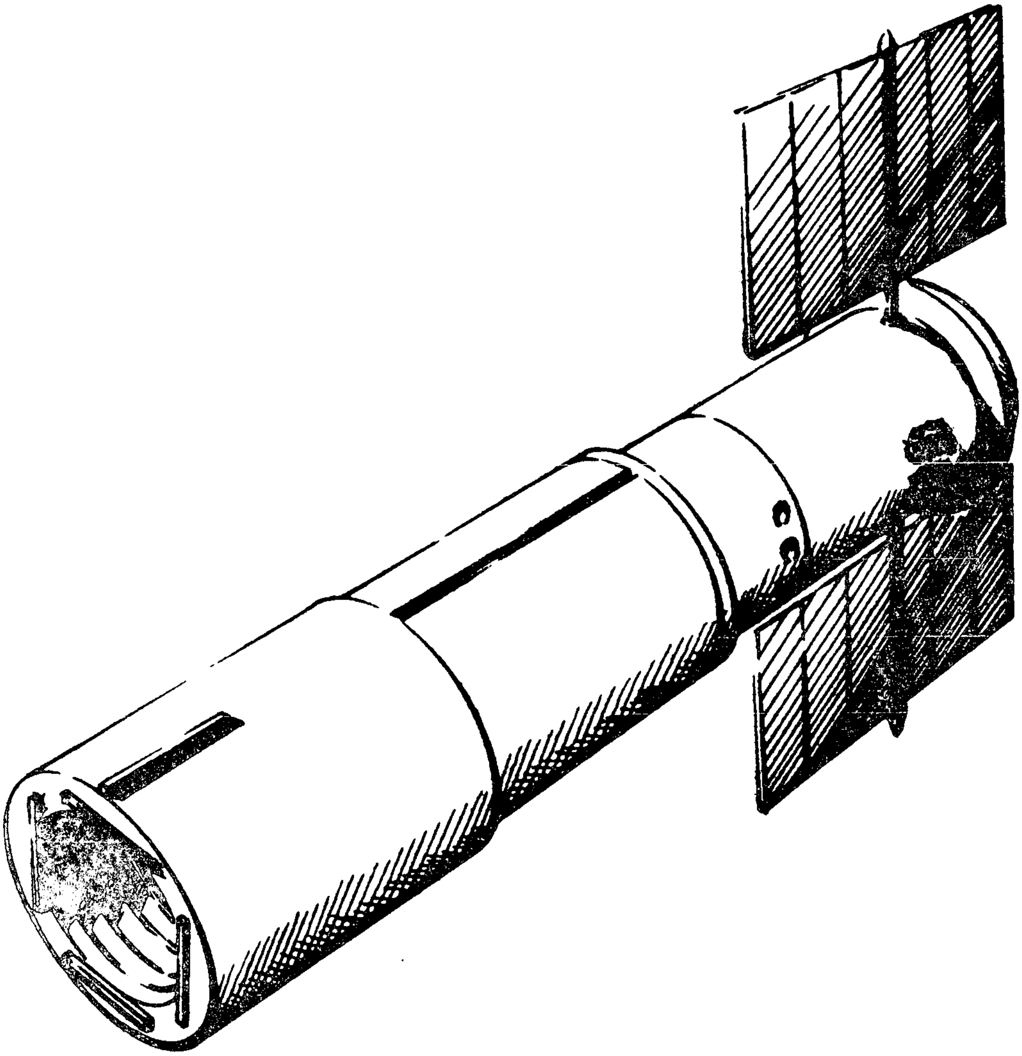
Expected Maintenance Philosophy. ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

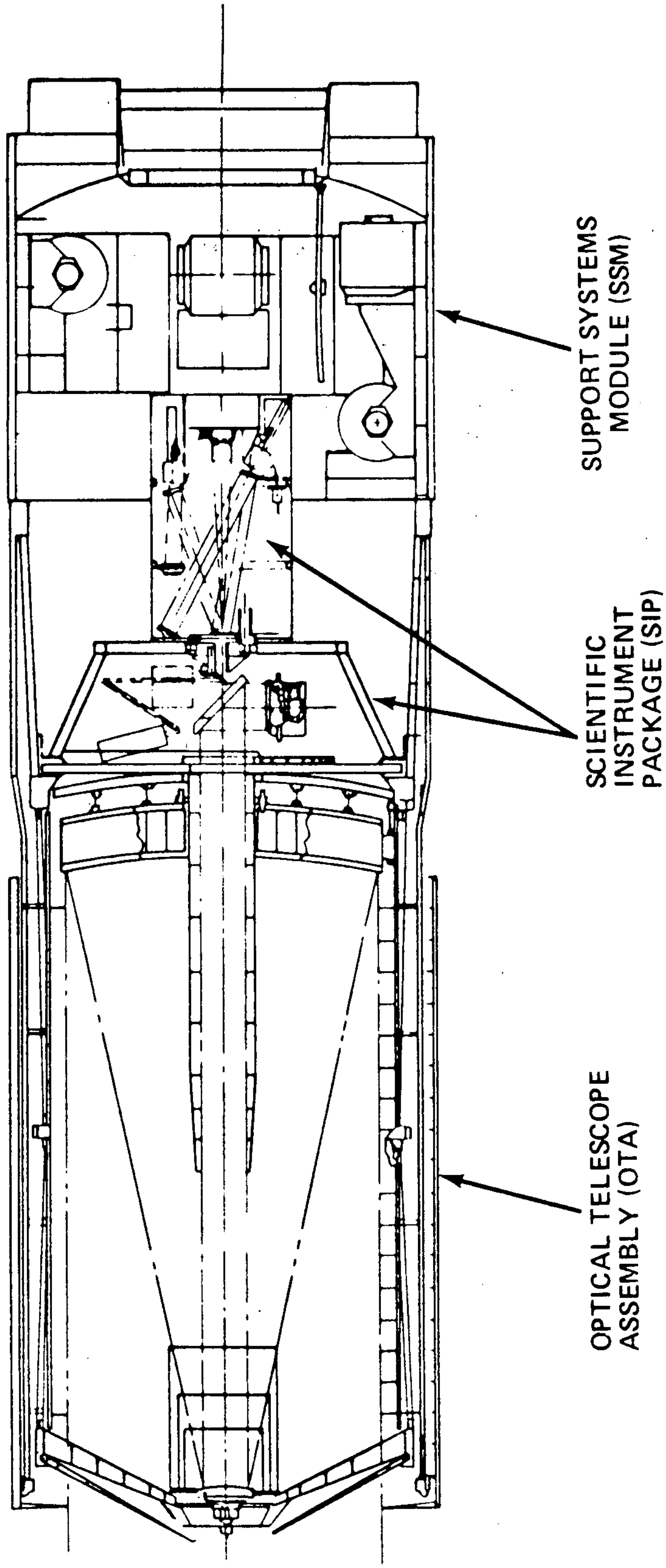
*On-orbit maintenance and modification, man-tended

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			1,060	(2,337)
Environmental Control			135	(298)
Guidance, Navigation, Stabilization			---	---
Propulsion Propellant Subsystem Dry			---	-----
Attitude Control (Mass Expulsion) Propellant (GN_2) Subsystem Dry	 115 892	 (254) (1,966)	1,007	(2,220)
Telemetry, Tracking, Command			82	(181)
Electrical, Solar Cells Batteries Conversion Conditioning Distribution Solar Cells (Cells are 100% redundant)			639	(1,409)
Mission Equipment			5,505	(12,136)
Total Weight - Dry			8,313	(18,327)
Total Weight - Including Expendables			8,428	(18,581)
Adapter			841	(1,850)
Launch Weight			9,269	(20,431)

Comments: ____________________



Large Space Telescope



SUPPORT SYSTEMS
MODULE (SSM)
SCIENTIFIC
INSTRUMENT
PACKAGE (SIP)
OPTICAL TELESCOPE
ASSEMBLY (OTA)

LST

Instrument Performance Summary

Instrument	Spectral Range, nanometers	Resolution
f/12 camera (ultraviolet)	150	0.2 arc-second
f/12 camera (visible)	600	0.15 arc-second
f/96 camera (ultraviolet)	150	0.06 arc-second
f/96 camera (visible)	300	0.10 arc-second
Imaging spectrograph	105 to 300	0.01 nanometer
High-speed spectrograph	105 to 300	0.1 nanometer
Echelle spectrograph	120 to 240	0.0012 to 0.0024 nanometer
Lyman spectrometer	90 to 120	0.01 nanometer
Near infrared spectrograph	500 to 1000	0.5 nanometer
Mid-infrared spectrograph	1000 to 2500	0.03 to 0.11 nanometer
Wollaston polarimeter	200 to 350	99.95 percent polarized
Reflection polarimeter	90 to 200	95 percent polarized

PAYLOAD DATA SHEET

TITLE: Large Space Telescope - Revisits

AGENCY: NASA/OSS

CODE: NA2-6

PROGRAM: Astronomy

COGNIZANT ENGINEER: M. J. Aucremanne

COGNIZANT SCIENTIST: N. Roman

MISSION OBJECTIVES: Revisit Large Space Telescope to perform instrument change, extend life of satellite, and resupply expendables

Spacecraft Description: Teleoperator/Manipulator and resupply modules

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:

611 (330) / 611 (330) / 28.5^{o}

Launch Window: Rendezvous

Initial Launch Date: 1980 yr No. of Satellites in System: None

System Expected Lifetime: Resupply

Satellite Mean Mission Duration: 2 wk

Satellite Desired Availability: On demand

Characteristic Velocity: 8,039 m/sec (26,374 ft/sec)

Satellite Weight: 1,587 kg (3,500 lb)*

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 1.52 m (5.0 ft) (vol) 25.1 m^3 (885.0 ft^3)

General Comments:

* Excludes Teleoperator/Manipulator

MISSION EQUIPMENT Code NA2-6

Weight: 1,542 kg (3,400 lb) Power: 200 W

Type of Experiment(s): Resupply

Purpose of Experiment(s): Resupply

Type of Sensor(s): Replacement modules and expendables

Unique Sensor Requirements and Technology Status: Remotely change out modules and resupply expendables

Environmental Requirements: No effluents or contamination affecting optics

Data Processing and Transmission Requirements: 3 kbps

Attitude Control and Pointing Accuracy Requirements: $\pm$ 1.0 deg (nominal docking requirements)

Propulsion Requirements: Rendezvous, stationkeeping, and docking

SUPPORTING SUBSYSTEMS Code NA2-6

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Shuttle

Guidance and Navigation Requirements: Shuttle

Propulsive Requirements: Shuttle

Type Propellant: Shuttle Thrust:

Orbit Adjust: Shuttle Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: Shuttle

Pointing Accuracy: $\pm$ 1 deg Pointing Direction:

Tracking, Telemetry and Command Requirements: 3 kbps

Antennas: Shuttle

Computers: Commands:

Type of Electrical Power System: Shuttle

Average Power: 200 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE　　　　Code NA2-6

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

- Electrical X
- Environment X
- Checkout X
- Other ______

Visits:

No. of Visits per Year: 2

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ______ hr

Requirement for Retrieval:* Yes X No ______ Desirable ______

Expected Maintenance Philosophy: NA

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

* On-orbit maintenance and modifications - man-tended

WEIGHTS

Code NA2-6

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms Teleoperator/Manipulator			680*	(1,500)*
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			22.7	(50)
Electrical Batteries Conversion Conditioning Distribution			22.7	(50)
Mission Equipment			1,542	(3,400)
Total Weight			1,587	(3,500)
Adapter			0	(0)
Launch Weight			1,587	(3,500)

Comments: *Teleoperator/Manipulator is a universal tool for use by this and other payloads; not included in total weight.

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PAYLOAD DATA SHEET

TITLE: Large Solar Observatory AGENCY: NASA/OSS

CODE: NA2-7

PROGRAM: Astronomy COGNIZANT ENGINEER: R. Chase

COGNIZANT SCIENTIST: G. Oertel

MISSION OBJECTIVES: High resolution visual and UV studies of solar granular structure and areas of high solar activities; continue UV and x-ray observations with higher spatial and spectral resolutions.*

Spacecraft Description: High resolution boresighted solar instruments group capable of being pointed at any selected location on the sun

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:

500 ± 102 (270 ± 55) / 500 ± 102 (270 ± 55) / 28.5° to 95°

Launch Window: None days

Initial Launch Date: 1986 yr No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 14,642 kg (32,282 lb)

Satellite Launch Dimensions: (diam) 4.3 m (length) 16.5 m (vol) 235 m^3

(14.0 ft) (54.0 ft) (8,300 ft^3)

General Comments: * The objectives included in Ref. 6 as defined by the solar community relates "to the physics of the photosphere and lower chromosphere, the upper chromosphere and lower corona, and the corona." Six instruments to cover the wavelength range from near IR through x-ray.

See Ref. 6

See Ref. 7

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MISSION EQUIPMENT Code NA2-7

Weight: 7,362 kg (16,231 lb) Power: 1070 kW avg, 1395 kW peak

Type of Experiment(s): Physics of sun: microturbulence, flare, elemental abundances, and velocity fields

Purpose of Experiment(s): Obtain radiometric, photometric, and spectrographic data for better understanding of solar structure.

Type of Sensor(s): Visible photoheliograph and telescope, spectrograph/ spectroheliograph, UV spectroheliograph and telescope, coronagraph, EUV spectroheliograph, x-ray spectroheliograph, flare detector, and collimator

Unique Sensor Requirements and Technology Status: 0.1 arc sec resolution (see attachment)

Environmental Requirements: Shield sensor against radiation and effluence.

Data Processing and Transmission Requirements: 10^8 bits/image

Attitude Control and Pointing Accuracy Requirements: 0.1 arc sec jitter; 0.1 arc sec/sec drift; 10 arc sec control pointing error (1 arc sec determination)

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA2-7

Unique Structural Requirements: Light weight thermally stabilized structure, endo type

Environmental Control Requirements: Active thermal control system

Guidance and Navigation Requirements:

Propulsive Requirements:

Type Propellant: N_2H_4 Thrust: 2.3 N (0.5 lb) - 12 thrusters redundant

Orbit Adjust: None Total Impulse: 667,000 N-sec (150,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: Desaturation; 3-axis, wheels, star trackers

Pointing Accuracy: 1 arc sec determination Pointing Direction: Sun

Tracking, Telemetry and Command Requirements: Use USB system; data storage 10^9 bits, 10^6 bps

Antennas: 2 to 3, 0.15 to 0.3 m (0.5 to 1 ft) diam, omni/low gain, S-band

Computers: Data compression reqm't Commands: 256 - 512 (32 bits) real time and stored

Type of Electrical Power System: Solar array and battery

Average Power: 2.0 kW Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NA2-7

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: 8 hr to 3 days

Requirement for Retrieval:*Yes X No ____ Desirable ____

Expected Maintenance Philosophy. ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

* On-orbit maintenance - man-tended

Code NA2-7

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms* Basic	2,295	(5,060)	4,114	(9,069)
Equipment Supports	1,819	(4,009)		
Environmental Control*			709	(1,562)
Guidance, Navigation, Stabilization*			816	(1,800)
Propulsion*			---	---
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)*			680	(1,500)
Propellant	544	(1,200)		
Subsystem Dry	136	(300)		
Telemetry, Tracking, Command*			172	(380)
Electrical, (2 kW)*			789	(1,740)
Batteries & Solar Array	544	(1,200)		
Conversion				
Conditioning				
Distribution	245	(540)		
Mission Equipment** (see attachment)			7,362	(16,231)
Total Weight - Dry			14,098	(31,082)
Total Weight - Including Expendables			14,642	(32,282)
Pallet			1,925	(4,244)
Launch Weight			16,567	(36,526)

Comments: * For spacecraft, see Ref. 7

** For mission equipment, see Ref. 6

NA2-7 - Attachment

	kg	(lb)
<u>Mission Equipment*</u>		
1.5 m photoheliograph	2,501	(5,513)
Spectrograph/spectroheliograph	500	(1,103)
1.0 m ultraviolet telescope	2,000	(4,410)
Ultraviolet spectroheliograph	500	(1,103)
Coronagraph	410	(904)
Extreme ultraviolet spectroheliograph	400	(882)
X-ray spectroheliograph	400	(882)
Crystal spectroheliograph	400	(882)
Flare detector	150	(331)
High energy X-ray collimator	100	(221)
	7,361	(16,231)

* Ref. Scientific Objectives and Instrumentation Performance Criteria for a Large Solar Observatory, E. Mayfield, et al, Aerospace Corporation, May 1972

Telescope and Instrument Requirements for the LSO

Instrument	Aperture, m	Wavelength Range	Resolution, arcsec	Field of View	Provisional Dimensions, m w	h	l	Remarks
Photoheliograph	1.5	0.2-2.0 μm	0.1	4 arcmin	1.8	2.0	3.0	Primary image photograph, spectroscopy
Spectrograph/ spectroheliograph	-	0.2-1.5 μm	0.1	4 arcmin	0.5	1.0	4.0	Spectra, magnetic and velocity fields
Ultraviolet telescope	1.0	0.06-0.2 μm	0.1	4 arcmin	1.3	1.5	3.0	Primary image photograph, spectroscopy
Ultraviolet spectroheliograph	-	0.06-0.2 μm	0.1	4 arcmin	0.5	0.5	3.0	Spectra, line profiles, photoelectron scan
Coronagraph	0.9	0.4-0.7 μm	1.0	15 deg	0.7	0.9	3.4	Corona, 1-6, 5-30 solar radii
Extreme ultraviolet spectroheliograph	0.6	100-600 Å	0.5	5 arcmin	0.5	1.0	10	Spectroheliograms, line profiles
x-Ray spectroheliograph	0.6	5-140 Å	1.0	5 arcmin	0.5	1.0	10	Spectroheliograms, filtergrams
Crystal spectroheliograph	0.25	1-6 Å	1.0	1 arcsec (rastered)	0.5	2.0	8.0	Spectral line profiles
Flare detector	0.1	0.5-4 keV	<1.0	Full disk	0.1	0.1	10	Active region, flare location and study
High-energy x-ray collimator	0.50	0.02-10 MeV	1.0	Full disk	0.5	1.0	6.0	Polarization, bursts

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PAYLOAD DATA SHEET

TITLE: Large Solar Observatory - Revisits

AGENCY: NASA/OSS

CODE: NA2-8

PROGRAM: Astronomy

COGNIZANT ENGINEER: R. Chase

COGNIZANT SCIENTIST: G. Oertel

MISSION OBJECTIVES: Revisit Large Solar Observatory to perform instrument change and adjustment, extend life of satellite, and resupply expendables.

Spacecraft Description: Teleoperator/Manipulator and resupply modules

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
500 ± 102(270 ± 55) / 500 ± 102(270 ± 55 / 28.5° to 95°

Launch Window: Rendezvous

Initial Launch Date: 1987 yr   No. of Satellites in System: None

System Expected Lifetime: Resupply

Satellite Mean Mission Duration: 2 wk

Satellite Desired Availability: On demand

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 1,587 kg (3,500 lb)*

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 1.52 m (5.0 ft) (vol) 25.1 m^3 (885 ft^3)

General Comments:

* Excludes Teleoperator/Manipulator

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MISSION EQUIPMENT Code NA2-8

Weight: 1,542 kg (3,400 lb) Power: 200 W

Type of Experiment(s): Resupply

Purpose of Experiment(s): Resupply

Type of Sensor(s): Replace modules and expendables

Unique Sensor Requirements and Technology Status: Remotely change out modules and resupply expendables.

Environmental Requirements: No effluents or contaminates affecting optics

Data Processing and Transmission Requirements: 3 kbps

Attitude Control and Pointing Accuracy Requirements: $\pm$ 1.0 deg (nominal docking requirements)

Propulsion Requirements: Rendezvous, stationkeeping, and docking

SUPPORTING SUBSYSTEMS — Code NA2-8

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Shuttle

Guidance and Navigation Requirements: Shuttle

Propulsive Requirements: Shuttle

Type Propellant: Shuttle Thrust: ______

Orbit Adjust: Shuttle Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: Shuttle

Attitude Control: Shuttle

Pointing Accuracy: $\pm$ 1 deg Pointing Direction: ______

Tracking, Telemetry and Command Requirements: 3 kbps

Antennas: Shuttle

Computers: ______ Commands: ______

Type of Electrical Power System: Shuttle

Average Power: 200 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE   Code NA2-8

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

- Electrical X
- Environment X
- Checkout X
- Other ___

Visits:

- No. of Visits per Year: 1
- Payload per Visit: 1,587 kg (3,500 lb)
- Purpose of Visit: Refurbish X Replace X
  Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

Expected Maintenance Philosophy: NA

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ___

Code NA2-8

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms Teleoperator/Manipulator			680	(1,500)*
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			22.7	(50)
Electrical Batteries Conversion Conditioning Distribution			22.7	(50)
Mission Equipment			1,542	(3,400)
Total Weight			1,587	(3,500)
Adapter			0	(0)
Launch Weight			1,587	(3,500)

Comments: * Teleoperator/Manipulator is a universal tool for use by this and other payloads; not included in total weight.

PAYLOAD DATA SHEET

TITLE: Large High Energy Telescope (X-ray)   AGENCY: NASA/OSS

CODE: NA2-9

PROGRAM: Astronomy   COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: ________

MISSION OBJECTIVES: a) Determine fundamental characteristics of interstellar and intergalactic matter and fields; b) Measure the emitted energy distribution of celestial objects*; and c) Determine and interpret the spatial and temporal distribution of celestial radiation sources**

Spacecraft Description: Resembles Large Space Telescope (see NA2-5)

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
740 (400) / 740 (400) / $28.5^{\circ}\ {}^{+70^{\circ}}_{-0^{\circ}}$

Launch Window: None days

Initial Launch Date: 1989 yr   No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8,108 m/sec (26,600 ft/sec)

Satellite Weight: 7,158 kg (15,781 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 9.8 m (32.0 ft) (vol) 71.2 m^3 (2,513.3 ft^3)

General Comments:

* Stars and galaxies, quasars, and pulsars

** Electromagnetic spectrum

MISSION EQUIPMENT Code NA2-9

Weight: 4,241 kg (9,350 lb) Power: 530 W

Type of Experiment(s): Observe object at extreme cosmological distance

Purpose of Experiment(s): To study the structure, line spectra, and position of specific x-ray sources; the physical mechanism for x-ray emission; the energy of each source; and angular size of x-ray sources

Type of Sensor(s): High resolution x-ray telescope, large area x-ray telescope, proportional counter array, scintillation counter assembly, crystal spectrograph, and transient x-ray phenomena detector

Unique Sensor Requirements and Technology Status: Requires development of mirror fabrication, polishing, and coating techniques.

Environmental Requirements: Minimum contamination

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA2-9

Unique Structural Requirements: Endo

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Star tracker, sun sensor, gyro, and computer

Propulsive Requirements: Attitude control dump

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 3-axis control, CMG

Pointing Accuracy: ______ Pointing Direction: 2π steradian coverage

Tracking, Telemetry and Command Requirements: USB system

Antennas: ______

Computers: ______ Commands: ______

Type of Electrical Power System: Solar array and batteries

Average Power: 1500 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NA2-9

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch ___ Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 1

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

Expected Maintenance Philosophy ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

Requires launch by Shuttle and erection in orbit.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			1,057	(2,330)
Environmental Control			136	(300)
Guidance, Navigation, Stabilization			---	---
Propulsion Propellant Subsystem Dry			---	---
Attitude Control (Mass Expulsion)			1,005	(2,216)
Propellant	114	(252)		
Subsystem Dry	891	(1,964)		
Telemetry, Tracking, Command			82	(180)
Electrical, Solar Cells (800 W) Batteries Conversion Conditioning Distribution Solar Cells (Cells are 100% Redundant)			637	(1,405)
Mission Equipment*			4,241	(9,350)
Total Weight - Dry			7,044	(15,529)
Total Weight - Including Expendables			7,158	(15,781)
Adapter			658	(1,450)
Launch Weight			7,816	(17,231)

Comments: Spacecraft weight estimates based on Ref. 5

* The mission equipment weight was supplied by responsible engineers.

PAYLOAD DATA SHEET

TITLE: Large High Energy Telescope (X-ray) - Revisits

AGENCY: NASA/OSS

CODE: NA2-10

PROGRAM: Astronomy

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Revisit Large High Energy Telescope (X-ray) to perform instrument change and adjustment, extend life of satellite, and resupply expendables.

Spacecraft Description: Teleoperator/Manipulator and resupply modules

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
741 (400) / 741 (400) / $28.5^{\circ}\ {}^{+70}_{-0}$

Launch Window: Rendezvous

Initial Launch Date: 1990 yr

No. of Satellites in System: None

System Expected Lifetime: Resupply

Satellite Mean Mission Duration: 2 wk

Satellite Desired Availability: On demand

Characteristic Velocity: 8,108 m/sec (26,600 ft/sec)

Satellite Weight: 1,587 kg (3,500 lb)*

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 1.52 m (5.0 ft) (vol) 25.1 m^3 (885.0 ft^3)

General Comments:

* excludes Teleoperator/Manipulator

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MISSION EQUIPMENT Code NA2-10

Weight: 1,542 kg (3,400 lb) Power: 200 W

Type of Experiment(s): Resupply

Purpose of Experiment(s): Resupply

Type of Sensor(s): Replace modules and expendables

Unique Sensor Requirements and Technology Status: Remotely change out modules and resupply expendables

Environmental Requirements: No effluents or contaminates affecting optics

Data Processing and Transmission Requirements: 3 kbps

Attitude Control and Pointing Accuracy Requirements: $\pm$ 1.0 deg (nominal docking requirements)

Propulsion Requirements: Rendezvous, stationkeeping, and docking

SUPPORTING SUBSYSTEMS Code NA2-10

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Shuttle

Guidance and Navigation Requirements: Shuttle

Propulsive Requirements: Shuttle

Type Propellant: Shuttle Thrust: ______

Orbit Adjust: Shuttle Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: Shuttle

Attitude Control: Shuttle

Pointing Accuracy: $\pm$ 1 deg Pointing Direction: ______

Tracking, Telemetry and Command Requirements: 3 kbps

Antennas: Shuttle

Computers: ______ Commands: ______

Type of Electrical Power System: Shuttle

Average Power: 200 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NA2-10

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: 1,587 kg (3,500 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: NA

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

WEIGHTS

Code NA2-10

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms Teleoperator/Manipulator			680	(1,500)*
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			22.7	(50)
Electrical Batteries Conversion Conditioning Distribution			22.7	(50)
Mission Equipment Film Expendables Replacement Modules Storage Structure			1,542	(3,400)
Total Weight			1,587	(3,500)
Total Weight				
Adapter			0	(0)
Launch Weight			1,587	(3,500)

Comments: * Teleoperator/Manipulator is a universal tool for use by this and other payloads; not included in total weight.

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PAYLOAD DATA SHEET

TITLE: Radio Astronomy Observatory AGENCY: NASA/OSS

CODE: NA 2-11

PROGRAM: Astronomy COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: N. Roman

MISSION OBJECTIVES: Measure low frequency spectra of discrete cosmic radio sources and high angular resolution of these sources through the lunar occultation method

Spacecraft Description: A spin-stabilized double layer web, 10 km diam*

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 71,569 ± 37 (38,646 ± 20)/ 71,569 ± 37 (38,646 ± 20) / 28.5° ± 28.5°

Launch Window: None days

Initial Launch Date: 1990 yr No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 11,961 m/sec (39,241 ft/sec)

Satellite Weight: 1,083 kg (2,385 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 7.6 m (25.0 ft) (vol) 55.6 m^3 (1,963.5 ft^3)

General Comments: * Spacecraft injected into orbit while still in a compact configuration. Injection would be followed by deployment into a system consisting of a central observatory, a rhombic antenna, and four subsatellites.

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MISSION EQUIPMENT Code NA2-11

Weight: 635 kg (1,400 lb) Power: 75 W

Type of Experiment(s): Observations of lower radio frequencies above the ionosphere

Purpose of Experiment(s): Identify physical conditions in radio galaxies for setting luminosity criteria for cosmological distribution studies

Type of Sensor(s): 10 km rhombic antenna

Unique Sensor Requirements and Technology Status: Development required

Environmental Requirements:

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 1 deg

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NA2-11

Unique Structural Requirements: Deployable antenna 10 km diam

Environmental Control Requirements: Passive system

Guidance and Navigation Requirements: Centrifugal force generated by four rotating subsatellites

Propulsive Requirements:

Type Propellant: N_2H_4 Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor: None

Attitude Control: Spin

Pointing Accuracy: $<1^{\circ}$ Pointing Direction: Space

Tracking, Telemetry and Command Requirements: USB system.

Antennas:

Computers: Commands:

Type of Electrical Power System: Solar array and battery

Average Power: 150 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE   Code ____NA2-11____

Compatibility with Other Spacecraft in Shuttle: Yes ______ No ______

Access to Spacecraft in Shuttle Required: Prelaunch __X__ Post Launch __X__

Support Requirement on Shuttle During Transportation:

Electrical ____X____

Environment ____X____

Checkout ____X____

Other ____________

Visits:

No. of Visits per Year: ____________

Payload per Visit: ____________ kg (____________ lb)

Purpose of Visit: Refurbish ________ Replace ________

Maintain ________ Operate ________

Stay Time Required: __________ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: ____________________________________

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Large antenna (10 km) can be qualified in low earth orbit. Difficult to check this size antenna on the ground.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			136	(300)
Environmental Control			23	(50)
Guidance, Navigation, Stabilization			91	(200)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			91	(200)
Propellant	59	(130)		
Subsystem Dry	32	(70)		
Telemetry, Tracking, Command			59	(130)
Electrical, Solar array (75W)			48	(105)
Batteries, Conversion	20	(45)		
Conditioning	5	(12)		
Distribution	22	(48)		
Mission Equipment			635	(1400)
Webbing	381	(840)		
Equipment	254	(560)		
Total Weight - Dry			1024	(2255)
Total Weight - Including Expendables			1083	(2385)
Adapter			27	(60)
Launch Weight			1110	(2445)

Comments: Total mission equipment weight from mission model. Weight distribution based on statistical analysis.

I. OBJECTIVES*

The prime objective is to obtain useful angular resolution at kilometer wavelengths for low-frequency radio astronomy observations. The system consists of a spin-stabilized double-layered web 10 kilometers in diameter of conducting and nonconducting cylindrical filaments attached to four outer satellites equally spaced around the perimeter of the web and attached at the center to a 20-foot diameter spinning central observatory. The conducting filaments of the web comprise a large rhombic antenna and a pair of identical dipole arrays collinear with, and external to, the minor diagonal of the rhombic and symmetrically spaced inside of the overall 10-kilometer diameter. Each array has its own pattern and, when these are added in phase and in quadrature phase, produce two symmetric interferometer patterns. These are then multiplied separately with two independent and opposed rhombic beams which creates four independent unidirectional compound interferometer patterns. All patterns are in continuous operation at a number of discrete frequencies.

The four outer satellites and the web are initially packed symmetrically in the central cylindrical observatory which is the container for a complete payload for a Saturn 1-B vehicle. Since the overall payload weight is estimated to be several thousand pounds, it can therefore be placed into a nearly circular orbit beyond the magnetosphere. This orbiting telescope operates at a number of frequencies in the band of 100 kHz to 10 Mhz, with special design emphasis near 1 MHz.

II. SCIENTIFIC PROGRAM

The scope of the principal scientific objectives for a large radio telescope with high resolving power operating over a broad range of low frequencies can be indicated by giving the broad scientific objectives. The broad scientific objectives are: to measure the radio spectra of a large number of galactic and extragalactic radio sources in the frequency band from 10 kHz to 40 MHz; to obtain complete high resolution maps of the galactic and extragalactic radio emission over the above frequency band; to measure the character and variations of radio emission from the sun, planets and other sources and to search for variable absorption and

interplanetary scintillation effects; to measure the brightness distribution over the above frequency band across individual radio sources by using lunar occultations when the circumstances are appropriate; to determine the statistical parameters of the cosmic background noise fluctuations in order to test hypotheses regarding the distribution of radio sources in space.

The scientific objectives are to:

a. Measure the flux densities of several dozen extragalactic and galactic sources at a number of frequencies near 1 MHz.

b. Map the cosmic background noise level of the full sky at a number of frequencies from 0.1 MHz to 10 MHz.

c. Record variations of radio emission from the Sun, Jupiter and other variable radio sources, including the variations due to inhomogeneities in the interplanetary medium at a number of frequencies from 0.1 MHz to 10 MHZ.

III. OPERATIONAL REQUIREMENTS

This section will outline the instrumentation required to achieve the scientific objectives of extending radio source observations and background mapping to frequencies around 1 MHz.

A. Antenna Directivity and Bandwidth

An antenna with high directional gain (small beam area) is required to map the sky and measure the flux density of radio sources. In order to measure several dozen sources, a beam area of not more than about 80 square degrees is required. To achieve this resolution a large physical structure is required.

Any high gain antenna must have a precisely controlled geometrical configuration. If the shape changes, the antenna properties change. It is desirable to have a rigid geometry but this is not practical and some limits must be set on allowable deviations, since any deviation from the design shape degrades antenna gain and resolution, changes pattern shape which produces beam wandering, and degrades system sensitivity by structural vibrations.

B. Sky Coverage and Orbit

It is desirable to have the satellite outside the earth's magnetosphere for at least a sizable fraction of its life. This requires an apogee of at least 40,000 nautical miles. The choice of orbit will be influenced by studies of the dynamics of the large antenna and the distortions produced by internal and external perturbing forces. If an elliptical orbit were chosen with relatively low perigee the gravity gradient torque could be utilized to precess the spin axis for full sky coverage. This will excite the structure into oscillations and may distort the antenna beyond acceptable limits. It may be preferable to choose a nearly circular orbit and equip the telescope with an active precessional control system.

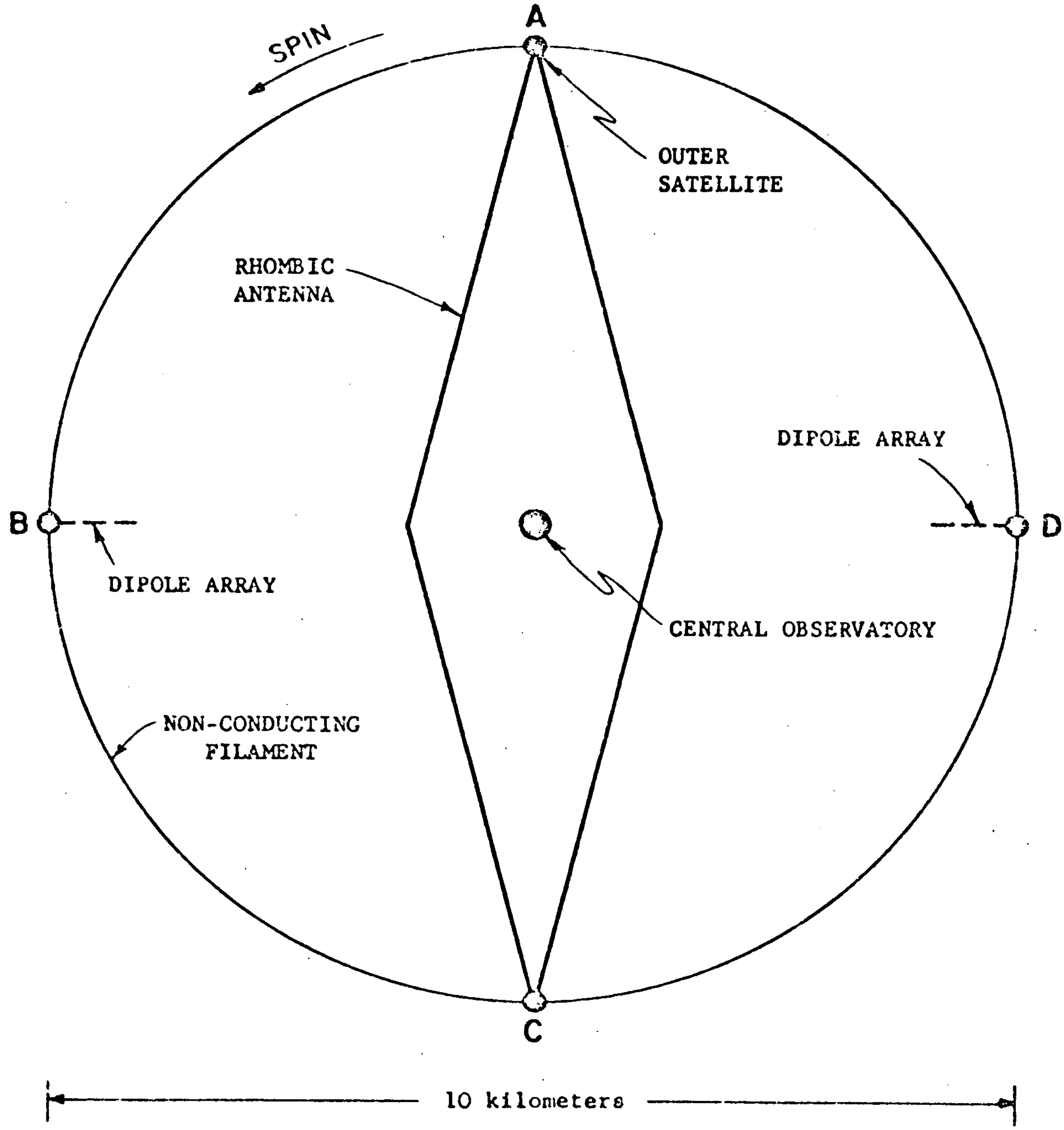
C. Stabilization and Pointing

The stabilization and the scanning of the antenna are mutually related. Ideally, one would like to have complete control over the pointing of the antenna. Since this is not practical, a good compromise appears to be a spin-stabilized structure with a symmetrical antenna system having unidirectional beams. Precession of the spin axis can provide full sky coverage. The longer the integration time, the longer it will take to cover fully a given zone of sky. The trade-off between integration time and scan rate will be studied further. Preliminary work indicates that adequate sensitivity is available.

The pointing of the antenna should be known to an accuracy of at least one degree. The required pointing accuracy is a function of the antenna beamwidth and the accuracy to which the pattern of the antenna is known or can be determined. Knowledge of the pattern and beamwidth may be obtained by monitoring the relative positions of the elements of the antenna and should be checked by a specially designed pattern-measuring space vehicle.

D. Sensitivity of Receivers

The cosmic background noise near 1 MHz is relatively intense. In fact, the cosmic noise power fed into the receivers will be several orders greater than the internally generated receiver noise. Therefore receiver noise is not a problem. The confusion between sources will be the limiting factor in measuring individual radio source flux densities.



Initial concept of kilometer wave orbiting telescope using rhombic antenna and a pair of dipole arrays as a compound interferometer and as a multi-beam radio telescope at several frequencies from 100 kHz to 10 MHz. Four outer satellites A, B, C, and D contain radiometers, aspect sensors, radio-controlled microrockets, etc. Supporting web not shown.

Large Space Radio Telescopes

If radio astronomy in the long-wave part of the spectrum is to have the capability of observing reasonable numbers (perhaps a hundred or more) of discrete radio sources, antenna systems of large size will be needed. As an example, at a frequency of 1 MHz (300 meters) a filled-aperture antenna needs to be 10 km across in order to give a bandwidth of 2 degrees. Antennas of this size would still have a very poor angular resolution when compared with most present-day ground-based instruments. Since the flux from radio sources is high in this long-wave region the large aperture required for resolving power need not be fully filled to provide a large collecting area. The degree of filling required depends on the type of observation.

The long wavelengths also give considerable relief in the structural and dimensional antenna tolerances which are needed. These, as in ground-based telescopes, need to be maintained to only about $\lambda/16$. The pointing precision, or knowledge of the direction in space toward which the radio beam of the telescope is pointed, again needs to be known to only about one-twentieth of the radio beamwidth.

Since any antenna system used at these wavelengths is always receiving signals from the sky background, which has a brightness temperature of the order of 10^7 deg K, the requirement for low-noise radiometers is not stringent. Problems connected with the behavior of the antenna impedance, pattern, and collecting area, both because of the need for operation over a wide frequency range and because of its immersion in a plasma, are quitc serious. They are, however, presently under study and are partially understood.

The mechanical problems of designing, launching, unfolding, or erecting, and using a large radio antenna in space can be discussed only in general terms. It seems certain that a structure made basically of wires held in place by some stabilizing system could meet the needs and be practical. Stabilization with a few small vehicles carrying thrust devices or possibly with gravity gradient methods might work.

Any antenna system of large size could be used over a period of several years for many different programs. It would be very reasonable to use the ability of men to erect, visit, adjust, modify, or repair the system from time to time.

*Data obtained from Physics and Astronomy Division NASA/OSS in 1971 ("Engineering Feasibility Study of a Kilometer Wave Orbiting Telescope," University of Michigan, 1966).

PAYLOAD DATA SHEET

TITLE: Astronomy/Physics Observations - Sortie **AGENCY:** NASA/OSS

CODE: NA2-12

PROGRAM: Astronomy **COGNIZANT ENGINEER:** A. Sures

COGNIZANT SCIENTIST: ____________

MISSION OBJECTIVES: To system-develop and perform experiments in astronomy and space physics

Spacecraft Description: Astronomy and physics experiments combined on one sortie mission

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55^{o}

Launch Window: None days

Initial Launch Date: 1979 yr **No. of Satellites in System:** 1

System Expected Lifetime: 1/50 yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 10,690 kg (23,569 lb) *

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 12.8 m (42.0 ft) (vol) 183.1 m^3 (6,465.4 ft^3)

General Comments: The experiments described herein are representative payloads. The various experiments that will be conducted in this area are: infrared, photoheliograph, cosmic ray, stellar, plasma physics, environment perturbations, atmospheric science, meteoroid physics, and chemistry.

* Weight breakdown - astronomy 4,177 kg (9,210 lb), physics 6,513 kg (14,359 lb)

See Ref. 8, 9, 10

MISSION EQUIPMENT Code NA2-12

Weight: 1,619 / 1,984 kg ((3,570) - astronomy / 4,373 - physics lb) Power: 0.6 kW - astronomy / 1.8 kW - physics

Type of Experiment(s): Solar astronomy; optical measurement of auroras and air glow; particle, environment, and VLF measurement; near wake, electron, and ion beam measurement

Purpose of Experiment(s): To develop a space laboratory and perform experiments on solar, space, and plasma physics, and environmental perturbation.

Type of Sensor(s): 1-m photoheliograph, UV and X-ray spectroheliograph, 10kW VLF transmitter, electron accelerator, telescope, photometric cluster, particle sensor

Unique Sensor Requirements and Technology Status: Photoheliograph pointing requirement, gimballed platform

Environmental Requirements: No organic effluents, 10^{-3} g

Data Processing and Transmission Requirements: 1.3 Mbps

Attitude Control and Pointing Accuracy Requirements: 10 arc sec pointing for astronomy and 120 arc sec for physics

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NA2-12

Unique Structural Requirements:

Environmental Control Requirements: ± 5° thermal control across photoheliograph optics and ± 1° for nuclear emulsion

Guidance and Navigation Requirements: ± 1 arc sec for astronomy experiment and ± 1° for physics

Propulsive Requirements: None

Type Propellant: None Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: Gimbal for optics and Shuttle for physics

Pointing Accuracy: ± 1° Orbiter Pointing Direction:

Tracking, Telemetry and Command Requirements: 1.3 Mbps plus film

Antennas:

Computers: Commands:

Type of Electrical Power System: Orbiter

Average Power: 2,400 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE

Code NA2-12

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: ____

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable ____

Expected Maintenance Philosophy: On-orbit maintenance

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Sortie mission possible only with Shuttle

WEIGHTS - ASTRONOMY

Code NA2-12

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			1,975	(4,355)
Cannister	274	(605)		
Gimbal Structure	1,302	(2,870)		
Equipment Support	399	(880)		
Environmental Control			281	(620)
Cooling	136	(300)		
Heat Pipe	48	(105)		
Expendables	36	(80)		
Insulation	61	(135)		
Guidance, Navigation, Stabilization			184	(405)
Gimbal Electronics	93	(205)		
Remote Controls	91	(200)		
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			27	(60)
Electrical			91	(200)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			1,619	(3,570)
Photoheliograph	1,361	(3,000)		
EUV Spectroheliograph	82	(180)		
X-ray Spectroheliograph (filter)	100	(220)		
X-ray Spectroheliograph(crystal)	77	(170)		
Total Weight			4,177	(9,210)
Pallet and Displays			583	(1,285)
Launch Weight			4,760	(10,495)

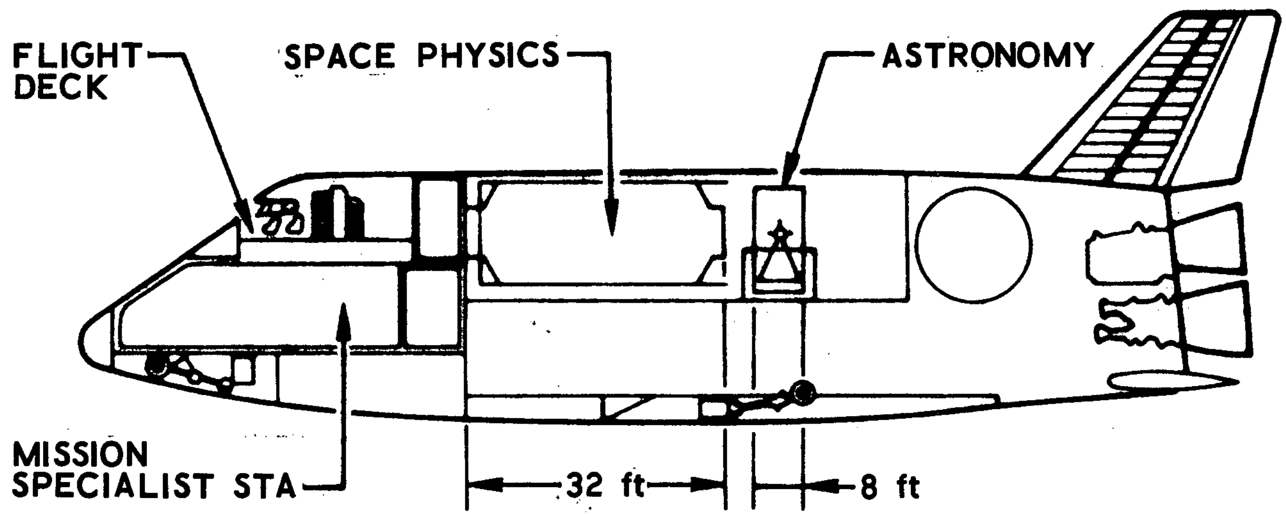
Comments: See Ref. 8

WEIGHTS - SPACE PHYSICS

Code NA2-12

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures			3,681	(8,116)
Structures	2,761	(6,087)		
Environ. Protection	810	(1,829)		
Docking	91	(200)		
Environmental Control			213	(470)
Atmos. & Thermal Control	184	(405)		
Life Support & Interiors	29	(65)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Telemetry			374	(825)
Data Management	95	(210)		
Communications	123	(270)		
Displays & Control	156	(345)		
Electrical			261	(575)
Conversion, Conditioning, Distribution	252	(555)		
Checkout	9	(20)		
Mission Equipment			1,984	(4,373)
Experiment Apparatus	581	(1,280)		
Specific Exp. Support	319	(704)		
Exp. Integ. Equipment	1,029	(2,269)		
Expendables	54	(120)		
Total Weight - Dry			6,459	(14,239)
Total Weight - Including Expendables			6,513	(14,359)
Crew Equipment - 114 kg (250 lb) and Residuals - 355 kg (780 lb)			467	(1,030)
Launch Weight			6,980	(15,389)

Comments: See Ref. 9 and 10, payload No. P5S1B



Sortie - Astronomy and Physics Observations (Typical)

V. Space Physics

PAYLOAD DATA SHEET

TITLE: Explorers - Upper Atmosphere AGENCY: NASA/OSS

CODE: NP2-13

PROGRAM: Space Physics COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: E. Schmerling

MISSION OBJECTIVES: Investigations of environment of the lower magnetosphere, neutral air chemistry and density, and ionospheric behavior

Spacecraft Description: Similar to the Atmosphere Explorers AE-C, -D, -E, and -F

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 185 - 333 (100 - 180) / 3333 - 3704 (1800 - 2000) / $90^\circ \pm 20^\circ$

Launch Window: ______ days

Initial Launch Date: 1973 yr No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: 70 %

Characteristic Velocity: 8,645 m/sec (28,362 ft/sec)

Satellite Weight: 526 kg (1160 lb)

Satellite Launch Dimensions: (diam) 1.22 m (length) 2.44 m (vol) 2.83 m^3

(4.0 ft) (8.0 ft) (100.0 ft^3)

General Comments:

MISSION EQUIPMENT Code NP2-13

Weight: 45 kg (100 lb) Power: 100 W

Type of Experiment(s): Ion spectrometers, RF probes, neutral mass spectrometers, UV sensors, drag device, etc.

Purpose of Experiment(s): Cause/effect studies which directly relate UV (incoming to ambient atmosphere) to resulting ionization

Type of Sensor(s): Electron multipliers, current collectors, VLF radio receivers, mass spectrometer, pressure gauges, magnetometer, UV detector, electric field detector, and drag device

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Natural

Data Processing and Transmission Requirements: Real time data rate 10^5 bps; playback data rate 10^6 bps; storage capacity 10^8 bits

Attitude Control and Pointing Accuracy Requirements: Point to $\pm$ 2 deg along pitch and yaw axes in despun mode; align pitch axis to $\pm$ 2 deg during spin

Propulsion Requirements: Orbit adjust; integral orbit change motor of 181 kg (400 lb) thrust

SUPPORTING SUBSYSTEMS Code NP2-13

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Passive system (no movable louvers), or active system for battery thermal control

Guidance and Navigation Requirements: 180 deg yaw-around capability

Propulsive Requirements: Orbit adjust and attitude control

Type Propellant: N_2H_4 Thrust: 23 N (5 lb) and 0.5 N (0.1 lb) (0.1 lb)

Orbit Adjust: Yes Total Impulse: 400,300 N-sec (90,000 lb-sec)

Apogee Kick Motor:

Attitude Control: As needed during orbit adjust; dual spin platform variable rate mode and platform despun mode; magnetic torquers

Pointing Accuracy: $\pm$ 2 deg Pointing Direction: Nadir oriented, rotary scan

Tracking, Telemetry and Command Requirements: Use USB system; real time data rate 10^3 - 10^4 Hz; playback data rate 10^5 - 10^6 Hz; transmitter RF power 20 to 37 dbm; data storage 10^7 - 10^9 bits

Antennas: 1 to 3, <0.3 m (<1 ft) diam, flush and horn, S-band

Computers: Data compression required Commands: 128 - 512 (32 bits)

Type of Electrical Power System: Solar array and battery

Average Power: 100 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE   Code NP2-13

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: No scientific advantage

WEIGHTS

Code NP2-13

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			109	(240)
Environmental Control			14	(30)
Guidance, Navigation, Stabilization			36	(80)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			236	(520)
Propellant	204	(450)		
Subsystem Dry	32	(70)		
Telemetry, Tracking, Command			45	(100)
Electrical			41	(90)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			45	(100)
Total Weight - Dry			322	(710)
Total Weight - Including Expendables			526	(1160)
Adapter			18	(40)
Launch Weight			544	(1200)

Comments: Based on mission model total weight, and expendable launch vehicle. Distribution based on statistical analysis.

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PAYLOAD DATA SHEET

TITLE: Explorers - Medium Altitude AGENCY: NASA/OSS

CODE: NP2-14

PROGRAM: Space Physics COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: E. Schmerling

MISSION OBJECTIVES: Measure ionospheric current systems and behavior with respect to solar activity; neutral atmosphere studies

Spacecraft Description: Small scientific satellites, spin-stabilized

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 1852 (1000) / 37,038 (20,000) / 0° to 90°

Launch Window: None days

Initial Launch Date: 1973 yr No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: 70 %

Characteristic Velocity: 11,275 m/sec* (36,993 ft/sec)*

Satellite Weight: 259 kg (570 lb)

Satellite Launch Dimensions: (diam) 1.52 m (5.0 ft) (length) 2.44 m (8.0 ft) (vol) 4.5 m^3 (157.0 ft^3)

General Comments: This Explorer is basically similar to the Upper Atmosphere Explorer except that a kick motor is not included.

* based on 28.5° inclination

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MISSION EQUIPMENT Code NP2-14

Weight: 45 kg (100 lb) Power: 30 W

Type of Experiment(s): Langmuir probes, mass spectrometers, and electric field spectrometers

Purpose of Experiment(s): Understand variability encountered in the middle magnetosphere

Type of Sensor(s): Solid-state detectors, ion and electron current monitors, photomultiplier tubes, scintillation counter, charge collectors, E field detectors, and magnetometer

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Natural

Data Processing and Transmission Requirements: Real time data rate 10^3 bps: data storage 10^8 bits

Attitude Control and Pointing Accuracy Requirements: $\pm$ 2 deg spin-axis alignment

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NP2-14

Unique Structural Requirements: Exo type

Environmental Control Requirements: Active system for batteries

Guidance and Navigation Requirements:

Propulsive Requirements:

Type Propellant: Cold gas GN_2 Thrust: 0.09 N (0.02 lb) - 2 thrusters

Orbit Adjust: No Total Impulse: 890 N-sec (200 lb-sec)

Apogee Kick Motor:

Attitude Control: Spin stabilized, magnetic torquers

Pointing Accuracy: ± 2 deg Pointing Direction: Spin axis normal to orbit plane

Tracking, Telemetry and Command Requirements: Use USB system; real-time data rate 10^3 - 10^4 Hz; playback data rate 10^5 - 10^6 Hz; command data rate 10^2 - 10^3 Hz; transmitter RF power 20 to 37 dbm; data storage 10^7 - 10^9 bits

Antennas: 1 to 3, 0.15 to 0.6 m (0.5 to 2 ft) diam, omni/low gain, S-band

Computers: Commands: 256-512 (32 bits), real-time and stored

Type of Electrical Power System: Solar array and battery

Average Power: 100 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE

Code NP2-14

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch ___ Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical ___

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: None

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish ___ Replace ___

Maintain ___ Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: No scientific advantage

Code NP2-14

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			98	(215)
Environmental Control			14	(30)
Guidance, Navigation, Stabilization			11.3	(25)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			4.5	(10)
Propellant	1.8	(4)		
Subsystem Dry	2.7	(6)		
Telemetry, Tracking, Command			45	(100)
Electrical			41	(90)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			45	(100)
Total Weight - Dry			257	(566)
Total Weight - Including Expendables			259	(570)
Adapter			15.9	(35)
Launch Weight			275	(605)

Comments: Weights based on use of expendable launch vehicle.

PAYLOAD DATA SHEET

TITLE: Explorers - High Altitude

AGENCY: NASA/OSS

CODE: NP2-15

PROGRAM: Space Physics

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: E. Schmerling

MISSION OBJECTIVES: Investigate interaction between solar wind and the earth's environment which produces the magnetosphere boundary and magnetosheath

Spacecraft Description: Similar to the IMP series; spin-stabilized spacecraft with spin axis orientation capability in a heliocentric orbit

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 1 A.U. ecliptic

Launch Window: None days

Initial Launch Date: 1973 yr

No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: 80 %

Characteristic Velocity: 12,192 m/sec (40,000 ft/sec)

Satellite Weight: 291 kg (640 lb)

Satellite Launch Dimensions: (diam) 1.22 m (4.0 ft) (length) 1.83 m (6.0 ft) (vol) 2.12 m^3 (75.0 ft^3)

General Comments:

MISSION EQUIPMENT Code NP2-15

Weight: 68 kg (150 lb) Power: 40 W

Type of Experiment(s): Magnetic field, electric field, energetic particle density and temperature, VLF noise

Purpose of Experiment(s): Increase understanding of the solar-terrestrial relationships which produce the magnetosphere and its boundaries

Type of Sensor(s): Magnetic field sensors, electric field sensors, high-energy particle spectrometers, solar wind spectrometers, VLF receivers

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Natural

Data Processing and Transmission Requirements: Data rate 10^6 bps

Attitude Control and Pointing Accuracy Requirements: $\pm$ 1 deg

Propulsion Requirements:

SUPPORTING SUBSYSTEMS

Code NP2-15

Unique Structural Requirements: Exo type

Environmental Control Requirements: Active system for batteries

Guidance and Navigation Requirements:

Propulsive Requirements:

Type Propellant: N_2H_4

Thrust: 2.3 N (0.5 lb) - 6 thrusters

Orbit Adjust: Yes Total Impulse: 53,400 N-sec (12,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: 0.1 deg for antennas; 3-axis, momentum wheels

Pointing Accuracy: ± 1 deg Pointing Direction: Gimbal mission equipment

Tracking, Telemetry and Command Requirements: Use USB system; telemetry data rate 10^2 - 10^6 Hz; command data rate 10^1 - 10^3 Hz; transmitter RF power 40-50 dbm; data processing equipment required; for data rates above 10^7, laser or mm-wave links to satellite relay

Antennas: 3 or 4, 0.15 to 3 m (0.5 to 10 ft) diam. high gain autotrack, S-band, X-band, laser, or mm-wavelength

Computers: Data compression required Commands: 256 - 512 (16 - 32 bits)

Type of Electrical Power System: Solar array and battery

Average Power: 300 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NP2-15

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch ___ Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical ___

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: None

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish ___ Replace ___

Maintain ___ Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: No scientific advantage

 Code NP2-15

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			54.4	(120)
Environmental Control			9.1	(20)
Guidance, Navigation, Stabilization			41	(90)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			41	(90)
Propellant	27	(60)		
Subsystem Dry	14	(30)		
Telemetry, Tracking, Command			32	(70)
Electrical			45	(100)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			68	(150)
Total Weight - Dry			264	(580)
Total Weight - Including Expendables			291	(640)
Adapter			9.1	(20)
Launch Weight			300	(660)

Comments: Weights based on use of expendable launch vehicle.

PAYLOAD DATA SHEET

TITLE: Gravity and Relativity Satellites - LEO

AGENCY: NASA/OOS

CODE: NP2-16

PROGRAM: Space Physics

COGNIZANT ENGINEER: C. D. Ashworth

COGNIZANT SCIENTIST: N. G. Roman

MISSION OBJECTIVES: Experimentally test Einstein's General Theory of Relativity by measuring the precession of orthogonal gyroscopes in earth orbit.

Spacecraft Description: Spacecraft subsystems and mission equipment must be integrated to support experiment consisting of precession gyros and telescopes in dewar at about 1.6° K.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 926 (500) / 926 (500) / 90° (true polar orbit)

Launch Window: None days

Initial Launch Date: 1979 yr No. of Satellites in System: 1

System Expected Lifetime: 1 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8,203 m/sec (26,913 ft/sec)

Satellite Weight: 462 kg (1,020 lb)

Satellite Launch Dimensions: 2.3 m (7.6 ft) diam / 4.3 m (14 ft) diam arrays deployed 3.7 m (12 ft) long including telescope light shield

General Comments: See Ref. 11

MISSION EQUIPMENT

Code NP2-16

Weight: 113 kg (250 lb) Power: ______ W

Type of Experiment(s): Relativity experiment using gyroscopes

Purpose of Experiment(s): Test the Relativity Theory

Type of Sensor(s): Precession gyros, star telescope, magnetometers, star tracker

Unique Sensor Requirements and Technology Status: Gyro system and telescope with a stability of 0.0005 arc sec per year and inertial pointing to 0.05 arc sec for 1 year; sensing requirement beyond present state of the art of gyro readout accuracy

Environmental Requirements: 10^{-9} g maximum acceleration

Data Processing and Transmission Requirements: 84 bps real time; 2300 bps playback

Attitude Control and Pointing Accuracy Requirements: 0.05 arc sec for 1 year inertial pointing; 0.0005 arc sec per year stability

Propulsion Requirements: Spacecraft attitude control to $\pm$ 1 arc sec and maintain drag free to 10^{-9} g

SUPPORTING SUBSYSTEMS — Code NP2-16

Unique Structural Requirements: Endo structure; gyros and telescope require dewar system to maintain about 1.6°K

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Gimbal to 0.05 arc sec

Propulsive Requirements: Use helium boiloff

Type Propellant: He — Thrust: 6 thrusters

Orbit Adjust: He — Total Impulse: ___ kg-sec (___ lb-sec)

Apogee Kick Motor: None

Attitude Control: 2 He thrusters; 4 gyros (2 parallel orbit plane, 2 perpendicular orbit plane)

Pointing Accuracy: ± 1 arc sec — Pointing Direction: Unique star

Tracking, Telemetry and Command Requirements: USB system; telemetry data rate 10^3 - 10^4 Hz; command rate 10^1 - 10^3 Hz

Antennas: Two, > 0.3 m (1 ft), omni/low gain, S-band

Computers: None — Commands: 64-128 (16 bits) real time and stored

Type of Electrical Power System: Solar array and battery

Average Power: 110 W — Peak Power: 220 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NP2-16

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

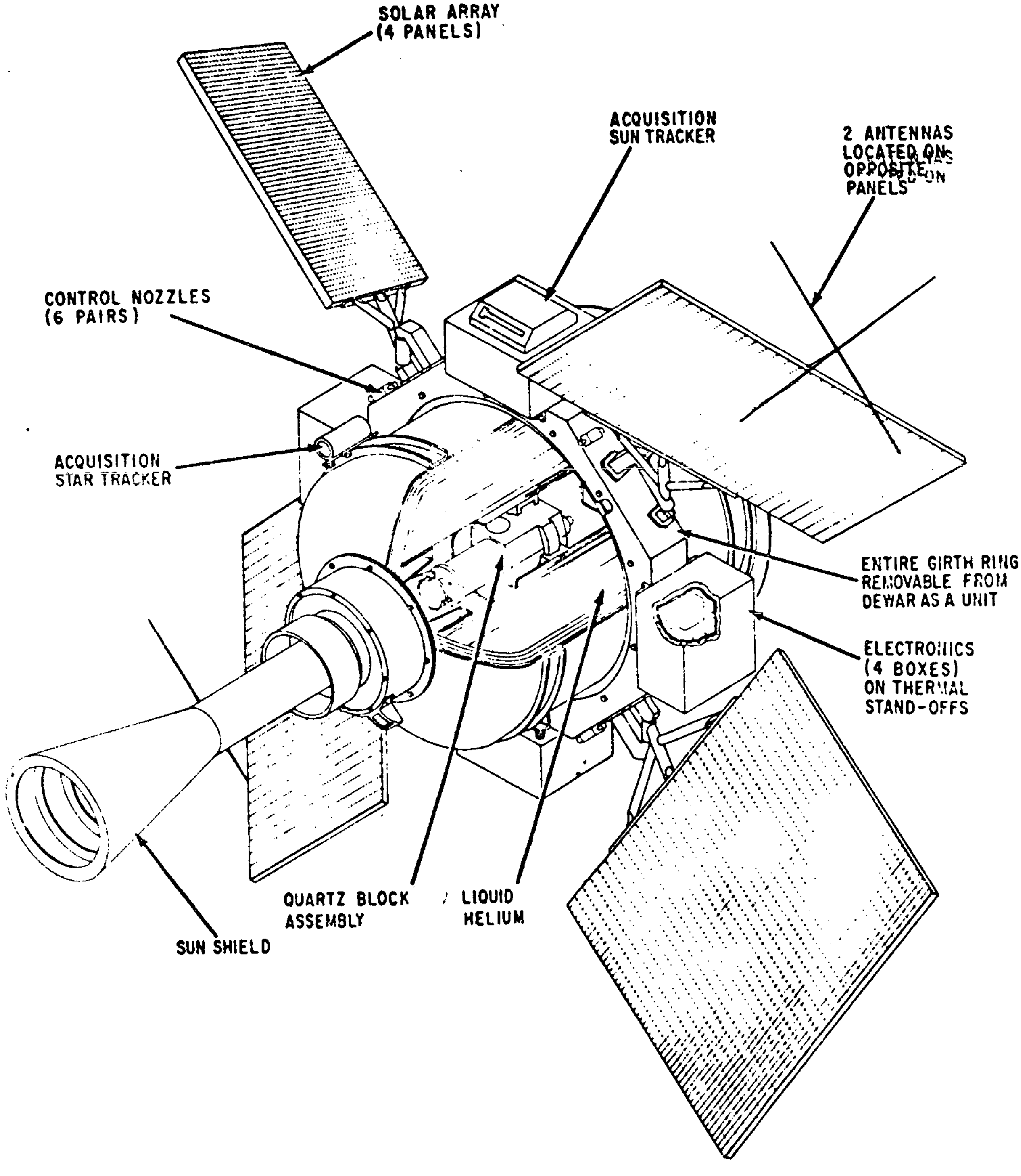
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Minimize launch tests, ensure operation prior to release from Shuttle, possible retrieval, check out thermal control in vacuum

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms*			31.8	(70)
Environmental Control			22.7	(50)
Guidance, Navigation, Stabilization			22.7	(50)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			154	(340)
Propellant (He)	136	(300)		
Subsystem Dry (uses thermal control boiloff)	18	(40)		
Telemetry, Tracking, Command				
Electrical**			118	(260)
Batteries, Conversion, Conditioning	109	(240)		
Distribution	9	(20)		
Mission Equipment			113	(250)
Total Weight - Dry			326	(720)
Total Weight - Including Expendables			462	(1020)
Adapter			27	(60)
Launch Weight			489	(1080)

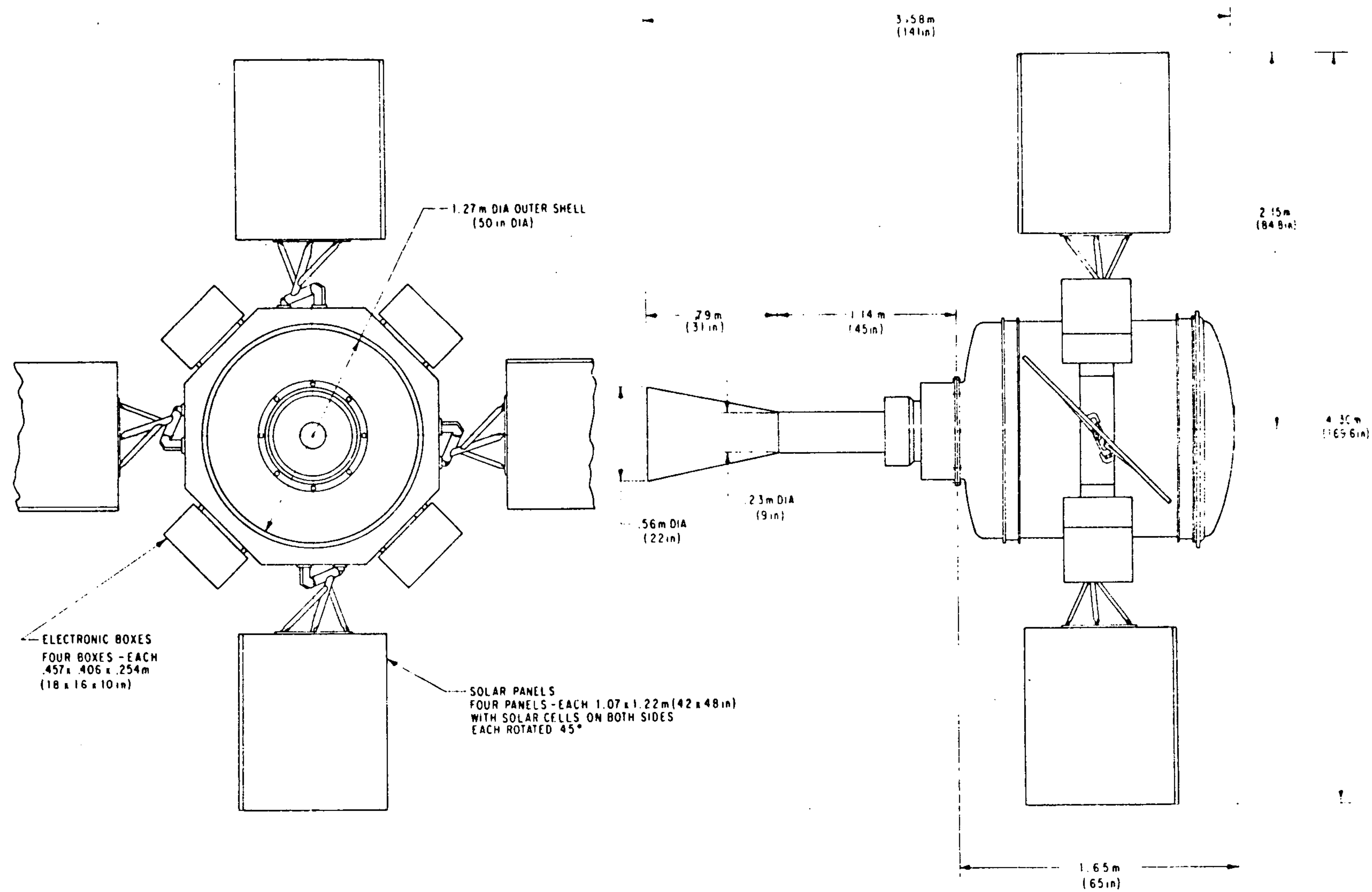
Comments: All weights based on use of expendable launch vehicle.

* Structural integral with thermal control

** 220 W



Stanford Relativity Satellite



Stanford Relativity Satellite - Deployed Configuration

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PAYLOAD DATA SHEET

TITLE: Gravity and Relativity Satellites - Solar

AGENCY: NASA/OSS

CODE: NP2-17

PROGRAM: Space Physics

COGNIZANT ENGINEER: P. D. Ashworth

COGNIZANT SCIENTIST: N. C. Roman

MISSION OBJECTIVES: 1) Test Einstein's General Theory of Relativity to determine the distinction between General Relativity and other theories through terms of the second order; 2) provide information on the mass quadrupole moment of the sun

Spacecraft Description: Spacecraft similar to HELIOS characterized by a drag-free system and including laser and multiple frequency ranging

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 0.3 A.U./1.0 A.U./ ecliptic plane

Launch Window: ________ days

Initial Launch Date: 1986 yr

No. of Satellites in System: 1

System Expected Lifetime: 1 to 2 yr

Satellite Mean Mission Duration: 1 to 2 yr

Satellite Desired Availability: ________ %

Characteristic Velocity: 14,569 m/sec (47,800 ft/sec)*

Satellite Weight: 349 kg (770 lb)

Satellite Launch Dimensions: (diam) 2.6 m (8.5 ft) (length) 2.1 m (6.8 ft) (vol) 10.9 m^3 (385.0 ft^3)

General Comments: * Direct orbit injection with no Venus flyby; velocity with Venus flyby ~12,200 m/sec (40,000 ft/sec)

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MISSION EQUIPMENT Code NP2-17

Weight: 68 kg (150 lb) Power: 150 W

Type of Experiment(s): Laser and multiple frequency ranging

Purpose of Experiment(s): Obtain information on the mass quadrupole moment of the sun

Type of Sensor(s): Drag-free sensor, telescope for laser ranging, S-band receiver, S- and X-band transmitters, quartz crystal clocks, proof-mass sensor, precision star tracker, and atomic clock

Unique Sensor Requirements and Technology Status: Development of laser system and proof-mass sensor

Environmental Requirements: 10^{-9} g

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements: Spacecraft attitude control and maintain drag-free (10^{-9} g)

SUPPORTING SUBSYSTEMS Code NP2-17

Unique Structural Requirements: Endo structure; maintain 1.6°K temperature for 1 year

Environmental Control Requirements: 0.3 A. U.

Guidance and Navigation Requirements: Gimbal to 0.05 arc sec

Propulsive Requirements: Maintain drag-free orbit

Type Propellant: He boiloff Thrust: 6 thrusters

Orbit Adjust: He boiloff Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: None

Attitude Control: 2 axis control, He thrusters

Pointing Accuracy: ± 1 arc sec Pointing Direction: Star

Tracking, Telemetry and Command Requirements: ______

Antennas: 2, < 0.3 m (1 ft), omni/high gain, S-, X-band, and lasers

Computers: ______ Commands: 64-128 (16 bits) real time

Type of Electrical Power System: Solar array and battery

Average Power: 220 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NP2-17

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X (System checkout) Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical ______

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain X Operate ______

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: ______

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Minimize launch costs, ensure operation prior to release from Shuttle, possible retrieval

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			68	(150)
Environmental Control			-	(-)
Guidance, Navigation, Stabilization			18	(40)
Propulsion			-	(-)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			45	(100)
Propellant	29.5	(65)		
Subsystem Dry	15.9	(35)		
Telemetry, Tracking, Command			32	(70)
Electrical*			118	(260)
Batteries	109	(240)		
Conversion				
Conditioning				
Distribution	9	(20)		
Mission Equipment			69	(150)
Total Weight - Dry			320	(705)
Total Weight - Including Expendables			349	(770)
Adapter			-	(-)
Launch Weight			349	(770)

Comments: Weights based on use of expendable launch vehicle.

* 220 W

GRAVITY PROBE-C
(ESRO RELATIVITY EXPERIMENT)*

DESCRIPTION

The ESRO sun-orbiting spacecraft is intended to measure the gravitational field close to the sun, where the field is large, through its effect on the motion of the spacecraft and on the propagation of electromagnetic signals.

Two technologically novel features will probably be incorporated in this experiment. First, the spacecraft will follow a true free-fall trajectory, independent of external influences such as radiation pressure and solar wind. This will be accomplished by slaving the spacecraft to a small proof-mass that is completely enclosed and hence protected from the environment and by compensating external forces with rocket thrusters. Second, the spacecraft will contain an atomic clock, with provision for laser and multiple radio-frequency ranging from earth. With these features, not only will the electromagnetic signal travel time be measurable with great precision, but also the orbit will provide, with greatly increased accuracy, the kind of second-order gravitational information that thus far has been obtained only from astronomical observations of the orbit of Mecury.

BACKGROUND

This experiment as well as the Stanford gyroscope and the SAO red shift experiments will test the theory of relativity so that the same arguments for START are applicable. In addition, the National Academy of Sciences in their Priorities report recommended that the feasibility of the ESRO experiment should be reviewed as soon as practicable---in order to implement this recommendation, funding should be available, starting in FY 1973, for appropriate studies in the United States.

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*Data obtained from Physics and Astronmy Division, NASA/OSS in 1971.

ESRO has approached NASA to determine our interest in cooperating with them in this experiment. Although no firm commitment had been made as of April 1971, NASA does plan to participate in defining the mission. ESRO has established a Mission Definition Group that will meet 3 or 4 times in the next year, and we plan to involve a total of 5 to 6 people from NASA Centers and Headquarters.

ESRO is studying the drag-free satellite, the maser, the possible orbits, the laser, the spacecraft requirements, etc., but no decision has been made for a flight project. The United States could contribute not only the NASA spacecraft and planning experience, but also efforts from such SRT projects as the hydrogen maser at the Smithsonian Astrophysical Observatory, the relativity gyroscope at Stanford University, the relativity work at the Jet Propulsion Laboratory, etc.

OBJECTIVES

The objectives of the ESRO relativity experiment are two-fold: (1) complement the test of Einstein's general relativity theory which can be provided by the Stanford gyroscope experiment to make possible the distinction between General Relativity and other theories through terms of the second order; and (2) provide information on the mass quadruple moment of the sun. This latter determination will have great astrophysical significance because the mass quadruple moment is related to the internal angular momentum of the sun, and hence, to the distribution of the original momentum of the proto-sun (i.e., between the condensed sun itself and its planetary system). This in turn can provide a valuable insight into the likelihood of the existence of planetary systems around stars other than the sun.

CHARACTERISTICS

The spacecraft design is under study by ESRO, and so only gross characteristics can be stated. The spacecraft will be a drag-free design controlled with the help of a ball-shaped proof-mass falling freely in a cage. In addition to the normal spacecraft subsystems, provision will have to be made for a laser and a multiple frequency ranging capability.

The exact orbit of this mission is also under study. However, it will be heliocentric and will probably require a Titan launch vehicle. The thermal design of the spacecraft is a potential problem area, as is the consideration of spin stabilization, since there is a requirement for an accurately pointing on-board telescope to view the laser.

GENERAL RELATIVITY EXPERIMENTS

Newtonian dynamics fails for large masses and high velocities; a better theory is Einstein's General Relativity (GR) which is essentially a mathematical construct - a general theory of gravitation. Due to the difficulties of observation, GR has been verified only approximately, (to about 10-20%); the three independent tests being: (1) advance in the perihelion of a planet (for Mercury this is 43 seconds of arc per century); (2) deflection of light at the limb of a star (for the sun it is 1.75 seconds of arc; recent experiments give about 2.0 seconds); (3) gravity shift of spectral lines toward the red in the spectrum of a star (in the sun it is small $\Delta u/uv \sim 2 \times 10^{06}$, but it is 30 times larger in the dense white dwarf star Sirius B). Alternatives to GR have been proposed, but the validity of these over GR depends on very fine discrimination by delicate experiments.

The proposed GR geocentric relativity satellite would provide a means of verifying GR by relativistic precession (with respect to the fixed stars) of a gyroscope in motion around the earth.

The earth-orbiting relativity experiment's twin pairs of gyroscopes will be subjected to two effects: the earth motion effect (gyroscope spin axes parallel to that of the earth) will cause precession of 7 sec of arc per year, and the earth rotation effect (spin axes perpendicular to the earth's), which will precess 0.05 sec of arc per year, according to General Relativity (GR). Brans-Dicke (BD) theory predicts a somewhat smaller precession for the earth-motion effect; the Brans-Dicke theory involves a multiplicative correction to GR, namely $\left(\frac{4+3w}{6+3w}\right)$, where w is a positive constant; clearly, the bracket will be somewhat less than unity, say ~ 0.9, so this experiment will indicate whether GR should be abandoned, or rather, whether BD should be considered.

The heliocentric relativity satellite (NPA-8) at perihelion will measure the gravitational field effects at 0.3 astronomical unit (A. U.), at which point the field intensity is a factor of 10 larger than that at the earth. The

effect of the variation of gravity field intensity as the satellite moves through its elliptical orbit out to 1.0 A.U. provides a means of studying the dynamical effects of the solar field on spacecraft motion and upon the propagation of electromagnetic signals.

In order to minimize dynamically perturbative effects such as solar wind and radiation pressure, a calibration "proof-mass" will be incorporated to insure that the spacecraft will follow a free-fall path. For testing the gravity effect on electromagnetic signal propagation, there will be an atomic clock and laser and radio signalling devices.

The motion of this satellite should reveal the existence of a mass quadrupole movement of the sun, and should be another and more precise check of General Relativity. In particular, an optically undetectible (0.1 sec of arc) polar flattening of 10^{-4} would result in a perihelion shift in Mecury of 8.3 sec of arc per century, which is 1/5 of the 43 seconds predicted by GR! This satellite provides a better test for choosing between GR and BD than the geocentric satellite.

PAYLOAD DATA SHEET

TITLE: Environment Perturbation Satellites - Mission A

AGENCY: NASA/OOS

CODE: NP2-18

PROGRAM: Space Physics

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST: E. Schmerling

MISSION OBJECTIVES: To test theories of the magnetosphere by investigating the effects of perturbing the medium.

Spacecraft Description: Satellite to carry an electron accelerator and a satellite* to monitor particle data

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 12,778 $\pm$ 926 (6900 $\pm$ 500) / 12,778 $\pm$ 926 (6900 $\pm$ 500) / $55^{o} \pm 30^{o}$

Launch Window: None days

Initial Launch Date: 1981 yr

No. of Satellites in System: 2*

System Expected Lifetime: 6 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 11,714 m/sec (38,431 ft/sec)

Satellite Weight: 1973 kg (4,350 lb)

Satellite Launch Dimensions: (diam) 2.1 m (7.0 ft) (length) 3.7 m (12.0 ft) (vol) 13.1 m^3 (461.8 ft^3)

General Comments: * Requires secondary monitoring satellite weighing approximately 14 kg (30 lb) and placed in 278 (150) / 14,815 (8000) / high inclined orbit.

MISSION EQUIPMENT Code NP2-18

Weight: 272 kg (600 lb) Power: 6 kW

Type of Experiment(s): Inject large quantities of electrons and chemicals into the magnetosphere and measure the effects.

Purpose of Experiment(s): To modify the particle distribution in the magnetosphere to investigate theories of particle trapping, entry, and exit.

Type of Sensor(s): Linear accelerator (300 Kev) and particle detector, chemical release cannister, electron spectrometers, VLF receivers, electron field probes

Unique Sensor Requirements and Technology Status: Linear accelerator and light weight power source

Environmental Requirements: High flux of Kev particles and local release of hemicals

Data Processing and Transmission Requirements: 10^3 Hz

Attitude Control and Pointing Accuracy Requirements: NA

Propulsion Requirements: NA

SUPPORTING SUBSYSTEMS Code NP2-18

Unique Structural Requirements: Exo

Environmental Control Requirements: NA

Guidance and Navigation Requirements: NA

Propulsive Requirements: NA

Type Propellant: N_2H_4 Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: Spin stabilized

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: Unified S-band

Antennas: Omni-directional

Computers: Commands:

Type of Electrical Power System: Solar and battery

Average Power: 6 kW Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NP2-18

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No ______ Desirable X

Expected Maintenance Philosophy: ______

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______

WEIGHTS

Code NP2-18

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			272	(600)
Environmental Control				
Guidance, Navigation, Stabilization			181	(400)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			159	(350)
Propellant	104	(230)		
Subsystem Dry	54	(120)		
Telemetry, Tracking, Command			91	(200)
Electrical, *			998	(2200)
Batteries, Conversion, Conditioning **	907	(2000)		
Distribution	91	(200)		
Mission Equipment			272	(600)
Accelerator	227	(500)		
Support	45	(100)		
Total Weight - Dry			1,869	(4,120)
Total Weight - Including Expendables			1,973	(4,350)
Adapter			68	(150)
Launch Weight			2,041	(4,500)

Comments: * 6 kW - 1 wk

** Solar or chem dynamic

Modification Experiment Lab*

1. Description

These missions would provide initial experimentation with earth environment modification, particularly the trapped radiation regions.

Mission A. Creation of an Artificial Radition Belt.

By means of ejecting 300 Kev electrons isotropically from an electron accelerator on-board a satellite moving in a circular orbit into a lunoidal volume bounded by magnetic shells at an altitude of approximately two earth radii (i.e. L = 3), it may be feasible to create an artificial Van Allen Belt.

Mission B. Deliberate Overloading of Natural Van Allen Belt so as to induce its Instability.

It is believed that the density of 40 Kev electrons in the magnetic shell near L = 3 is sufficiently close to its natural limit that it may be possible to inject a sufficient number of electrons at this energy that the natural limit will be exceeded. A possible result of this is that this particular Van Allen belt will be pushed beyond its stable limit thereby triggering dumping and loss processes whose observation would greatly illuminate the physics of such belts.

The satellite for Mission A would have to carry a specially designed electron accelerator and appropriate power supply and would weight approximately 3000 pounds. The launch vehicle required for such a mission would be, say, a Titan 3C. A secondary monitoring satellite would carry only telemetry equipment and particle detectors and would weigh approximately 30 pounds and could be launched into a 150 mile perigee - 8000 mile apogee orbit by a Scout launch vehicle. It may be desirable to have this satellite in an inclined orbit so that better coverage of the belt would be obtained.

For Mission B it is believed that an electron accelerator capable of delivering say 30 KW of energy continuously for a week would be able to supply a sufficient number of electrons. A rough estimate of the weight of such a device along with its power supply would be 10,000 pounds. To launch such a satellite into a circular orbit at an altitude of 2 earth radii would require a Titan 3C vehicle with a Centaur upper stage.

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*Data obtained from Physics and Astronomy Division, NASA/OSS in 1971.

2. Objectives

Monitoring an artificial belt could provide important information concerning diffusion processes and loss mechanisms. In addition, maintaining the electron distribution very near the threshold of instability (Mission B) would allow the belt to serve as a sensitive indicator to other natural geophysical perturbations. Capabilities and information gained by such a program could perhaps lead to ultimate control of the Van Allen belts, yielding such possible benefits as the prevention of ionospheric radio blackouts or the alleviation of radiation hazards to astronauts on long duration orbital missions.

3. State of Development

Only highly preliminary studies have been made up to this point. The scientific basis for these concepts comes from a University of Maryland document entitled "Report of Ad Hoc Committee on Environmental Modification Experiments in Space to the National Aeronautics and Space Administration, March 1968." Appropriate discussions of such a proposal as this should be undertaken in the scientific community in order to set priorities and decide on desirable goals. Given the level of spontaneous interest which seems to exist in this project at the present time, one might estimate that two to three years might elapse before natural discussion processes would develop the idea sufficiently that one could begin in earnest to plan such a project. Directed study could shorten this time, however, and then one might suppose that work could begin in, say, 1971.

For Mission A there would need to be developed a spaceborne electron accelerator capable of delivering a current of, say, 25 milliamperes at 300 KV continuously for a week and to match this device to an appropriate 6 kw power source. This would seem to be a substantial development project. Paper designs exist for accelerators having substantially larger energy outputs than this but with beam currents and operating times such that only 1/100 to 1/1000 of the required total number of electrons can be ejected.

Major technology requirements for Mission B include the development of a 40 KeV electron accelerator capable of sustaining a beam current of 3/4 ampere continuously for a week along with an accompanying 30 kilowatt power supply. Such a project could draw heavily on the technology developed in connection with the artificial radiation belt experiment (Mission A).

Detailed studies, both feasibility and scientific, need to be done to determine requirements for spacecraft design and to suggest meaningful measurement techniques and proposed mission plans.

PAYLOAD DATA SHEET

TITLE: Environment Perturbation Satellites - Mission B

AGENCY: NASA/OOS

CODE: NP2-19

PROGRAM: Space Physics

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To experiment with earth environment modification by a deliberate overloading of natural Van Allen Belt so as to induce its instability

Spacecraft Description: Satellite to carry an electron accelerator and a satellite * to monitor particle data

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 12,778 $\pm$ 926 (6900 $\pm$ 500) / 12,778 $\pm$ 926 (6900 $\pm$ 500) / $55^\circ {}^{+35^\circ}_{-0^\circ}$

Launch Window: None days

Initial Launch Date: 1987 yr

No. of Satellites in System: 1*

System Expected Lifetime: 6 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 11,714 m/sec (38,431 ft/sec)

Satellite Weight: 3,946 kg (8,700 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 4.6 m (15.0 ft) (vol) 33.4 m^3 (1,178.1 ft^3)

General Comments: * Requires monitoring satellite weighing approximately 14 kg (30 lb) and placed in 278 (150) / 14,815 (8000) / high inclination orbit.

MISSION EQUIPMENT Code NP2-19

Weight: 272 kg (600 lb) Power: 30 kW for 1 wk

Type of Experiment(s): Inject sufficient number of electrons to exceed the natural limit.

Purpose of Experiment(s): Van Allen Belt will be pushed beyond its stable limit, thereby triggering dumping and loss processes, the observation of which will illuminate the physics of the belt.

Type of Sensor(s): 40 Kev electron accelerator

Unique Sensor Requirements and Technology Status: Electron accelerator and 30 kW power supply

Environmental Requirements: High flux of Kev particles

Data Processing and Transmission Requirements: 10^3 Hz

Attitude Control and Pointing Accuracy Requirements: NA

Propulsion Requirements: NA

SUPPORTING SUBSYSTEMS Code NP2-19

Unique Structural Requirements: Exo

Environmental Control Requirements: NA

Guidance and Navigation Requirements: NA

Propulsive Requirements: NA

Type Propellant: N_2H_4 Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: Spin stabilized

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: Unified S-band

Antennas: Omni-directional

Computers: ______ Commands: ______

Type of Electrical Power System: Solar and battery

Average Power: 30 kW for 1 wk Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE — Code: NP2-19

Compatibility with Other Spacecraft in Shuttle: Yes: X No: ______

Access to Spacecraft in Shuttle Required: Prelaunch: X Post Launch: X

Support Requirement on Shuttle During Transportation:

- Electrical: X
- Environment: X
- Checkout: X
- Other: ______

Visits:

- No. of Visits per Year: NA
- Payload per Visit: ______ kg (______ lb)
- Purpose of Visit: Refurbish: X Replace: X Maintain: X Operate: X

Stay Time Required: ______ hr

Requirement for Retrieval: Yes: ______ No: ______ Desirable: X

Expected Maintenance Philosophy: ______

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______

Code NP2-19

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			544	(1200)
Environmental Control			91	(200)
Guidance, Navigation, Stabilization			181	(400)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			272	(600)
Propellant	227	(500)		
Subsystem Dry	45	(100)		
Telemetry, Tracking, Command			91	(200)
Electrical,*			2495	(5500)
Batteries, Conversion, Conditioning **	2268	(5000)		
Distribution	227	(500)		
Mission Equipment			272	(600)
Accelerator	45	(100)		
Electron Collector	181	(400)		
Support	45	(100)		
Total Weight - Dry			3719	(8200)
Total Weight - Including Expendables			3946	(8700)
Adapter			136	(300)
Launch Weight			4082	(9000)

Comments:

* 30 kW for 1 wk

** Solar or chem dynamic

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PAYLOAD DATA SHEET

TITLE: Heliocentric and Interstellar Spacecraft

AGENCY: NASA/OOS

CODE: NP2-20

PROGRAM: Space Physics

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To explore regions of the solar system that have not been explored by planetary satellites.

Spacecraft Description: Pioneer type

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Escape (out of ecliptic to nearest star)*

Launch Window: None days

Initial Launch Date: 1988 yr

No. of Satellites in System: 1

System Expected Lifetime: 12 yr

Satellite Mean Mission Duration: 7 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 16,600 m/sec (54,500 ft/sec)

Satellite Weight: 280 kg (616 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 3.0 m (10.0 ft) (vol) 22.2 m^3 (785.4 ft^3)

General Comments: * Solar probe to 0.05 A. U. is also a candidate.

MISSION EQUIPMENT — Code NP2-20

Weight: 30 kg (66 lb) Power: 25 W

Type of Experiment(s): Explore the region that has not been explored by interplanetary flights.

Purpose of Experiment(s): Map interplanetary magnetic field, solar wind, high energy charged particles; and search for asteroids and determine their size, mass, flux, and orbital data.

Type of Sensor(s): Meteoroid detector, magnetometer, particle detectors, cosmic ray telescope, radiometer, and UV photometer

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Magnetically clean satellite to minimize interference of the magnetometer measurement

Data Processing and Transmission Requirements: 50 kbit storage, 1 kbps from Jupiter distance

Attitude Control and Pointing Accuracy Requirements: 1 deg

Propulsion Requirements: Midcourse correction and attitude control

SUPPORTING SUBSYSTEMS Code NP2-20

Unique Structural Requirements: Endo

Environmental Control Requirements: Louvers, insulation, electric heaters. and radioisotope heaters

Guidance and Navigation Requirements: Ground controlled

Propulsive Requirements: Velocity correction, attitude change, and spin rate

Type Propellant: Hydrazine Thrust: 1.7 - 6.0 N (0.4 - 1.4 lb)

Orbit Adjust: 720 km (389 nmi)/hr Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 5 rpm spin stabilized

Pointing Accuracy: 1 deg Pointing Direction: earth

Tracking, Telemetry and Command Requirements: S-band, 1 kbps from Jupiter

Antennas: Omni-directional, medium, and high gain (9 ft)

Computers: ______ Commands: 1 bps rate

Type of Electrical Power System: Radioisotope thermoelectric generators

Average Power: 100 W Peak Power: 155 W

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE   Code NP2-20

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: None

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish ___ Replace ___

Maintain ___ Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: In-orbit checkout of the deployment of the RTG booms and subsystems

WEIGHTS Code NP2-20

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			67	(148)
Environmental Control			7	(15)
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			45	(99)
Propellant	27	(60)		
Subsystem Dry	18	(39)		
Telemetry, Tracking, Command			51	(112)
Electrical,			80	(176)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			30	(66)
Total Weight - Dry			253	(556)
Total Weight - Including Expendables			280	(616)
Adapter			14	(31)
Launch Weight			294	(647)

Comments: ______________________________

PAYLOAD DATA SHEET

TITLE: Physics Laboratories - Space Station RAM

AGENCY: NASA/OSS

CODE: NP2-21

PROGRAM: Space Physics

COGNIZANT ENGINEER: A. Sures

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To provide flexible facilities in space for conducting experiments relating to atmospheric and magnetospheric science, cometary physics, meteoroid science, and astronomy.

Spacecraft Description: Family of instruments and devices to perform four experiment categories: optical, environment, energetic particle, and meteoroid sensors from an orbiting station.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55°

Launch Window: Rendezvous with space station

Initial Launch Date: 1987 yr

No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: %

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 10,348 kg (22,811 lb)

Satellite Launch Dimensions: (diam) 4.3m (14.0 ft) (length) 12.8 m (42.0 ft) (vol) 183.0 m^3 (6,465.4 ft^3)

General Comments: Physics laboratory consists of: 1) Space Physics Research; 2) Plasma Physics and Environment Perturbation; 3) Cosmic Ray Physics; and, 4) Physics and Chemistry Laboratory. This data sheet has selected and combined the Space Physics (1) and Plasma Physics (2) as the representative Physics Laboratory.

See Ref. 9, 10

MISSION EQUIPMENT Code NP2-21

Weight: 4,518 kg (9,961 lb) Power: 1.9 kW

Type of Experiment(s): Measurements and observations of the ambient environment, incident energetic particles, and airglow emissions

Purpose of Experiment(s): To investigate the chemical and energy conversion processes that control the structure of the thermosphere and plasma wake around orbital bodies, plasma resonances, particle interaction with VLF, and electron beam propagation.

Type of Sensor(s): Optical, particle, meteoroid, ambient environment, particle accelerators, subsatellites, plasma sensors

Unique Sensor Requirements and Technology Status:

Environmental Requirements: Optical instruments sensitive to particles and gases

Data Processing and Transmission Requirements: 1.6 Mbps

Attitude Control and Pointing Accuracy Requirements: 1.6 arc sec pointing and 0.5 arc sec/sec stability

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NP2-21

Unique Structural Requirements: Endo

Environmental Control Requirements: Manned long duration station

Guidance and Navigation Requirements: Gimbal instrument

Propulsive Requirements: None

Type Propellant: ________ Thrust: ________

Orbit Adjust: ________ Total Impulse: ________ kg-sec (________ lb-sec)

Apogee Kick Motor: ________

Attitude Control: ________

Pointing Accuracy: ________ Pointing Direction: ________

Tracking, Telemetry and Command Requirements: 1.6 Mbps

Antennas: ________

Computers: ________ Commands: ________

Type of Electrical Power System: Orbiter

Average Power: 1.9 kW Peak Power: ________

Unique Interstage/Adapter Requirements: ________

SHUTTLE INTERFACE Code NP2-21

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 6

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

Expected Maintenance Philosophy: On-board maintenance and ground refurbishment on 2-year centers

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Eliminate need for propulsion, attitude control, power, and communication subsystems

WEIGHTS Code NP2-21

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			4,675	(10,306)
Structures	3,335	(7,352)		
Environ. Protection	991	(2,184)		
Docking	349	(770)		
Environmental Control			470	(1,035)
Atmosphere & Thermal Cond	333	(735)		
Life Support & Interiors	136	(300)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry			39	(85)
Data Management	25	(55)		
Command	14	(30)		
Electrical			646	(1,424)
Batteries	279	(614)		
Conversion, Conditioning, Distribution	123	(270)		
Wiring	236	(520)		
Checkout	9	(20)		
Mission Equipment			4,518	(9,961)
Experiment Apparatus	1,792	(3,951)		
Support	1,159	(2,556)		
Exp. Integration Equip.	1,460	(3,219)		
Expendables	107	(235)		
Total Weight Dry			10,241	(22,576)
Total Weight - Including Expendables			10,348	(22,811)
Crew Equipment - 61 kg(135 lb) and Residuals - 262 kg (577 lb)			323	(712)
Launch Weight			10,671	(23,523)

Comments: Weights based on Ref. 9 and 10, payload No. P6A3A-1

VI. Planetary Exploration

PAYLOAD DATA SHEET

TITLE: Mars Viking

AGENCY: NASA/OSS

CODE: NU2-22

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Describe the physical, chemical, and thermal properties of Mars upper and lower atmosphere; search for life and describe physical, chemical, and magnetic properties of the surface

Spacecraft Description: Combination orbiter and lander. Orbiter is modified Mariner 71; lander uses parachutes and terminal propulsion to achieve soft landing.

Periapsis km (n mi)/Apoapsis km (n mi)/Inclination deg: 1,502 (811)/33,034 (17,838/ NA (Mars orbit)

Launch Window: 20 days

Initial Launch Date: 1975 yr

No. of Satellites in System: 2

System Expected Lifetime: 2 1/2 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 11,552 m/sec (37,900 ft/sec)

Satellite Weight: 3,398 kg (7,491 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 4.9 m (16.0 ft) (vol) 51.2 m^3 (1,809.6 ft^3)

General Comments: Planetary sterilization required.

See Ref. 12.

MISSION EQUIPMENT Code NU2-22

Weight: Lander - 56 kg (124 lb) Power: ______ W

Type of Experiment(s): Physical, chemical, and thermal properties of Mars atmosphere and surface

Purpose of Experiment(s): Search for life and describe physical, chemical, and magnetic properties

Type of Sensor(s): IR radiometer, IR spectrometer, density gauges, TV, wind velocity monitors, soil sampler and analyzer, imagers, seismometer

Unique Sensor Requirements and Technology Status: ______

Environmental Requirements: Extreme surface temperature on Mars

Data Processing and Transmission Requirements: 10 Mb/day

Attitude Control and Pointing Accuracy Requirements: 1 deg pointing accuracy

Propulsion Requirements: Transfer corrections and retro for Mars orbit capture

SUPPORTING SUBSYSTEMS Code NU2-22

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Passive (louver) system

Guidance and Navigation Requirements: Star and sun sensors

Propulsive Requirements: Trajectory corrections, retro into Mars orbit (ΔV = 2,512-2,950 m/sec [8,240-9,680 ft/sec]), and orbital correction maneuvers

Type Propellant: N_2H_4 Thrust: 2,670 N (600 lb) and 4.4 N (1 lb)

Orbit Adjust: Yes Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: No

Attitude Control: 3-axis, wheels

Pointing Accuracy: 1 deg Pointing Direction: ______

Tracking, Telemetry and Command Requirements: UHF band for lander to orbiter; S-band for orbiter to earth; and S-band for lander to earth

Antennas: 2 omni-directional and 0.8 m (2.5 ft) dish on lander; and 1.2 m (4.0 ft) high-gain dish on orbiter

Computers: 10^9 bits storage Commands: ______

Type of Electrical Power System: Solar array and battery in orbiter; RTG and battery in lander

Average Power: 200 W in orbiter; 70 W in lander Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE　　　　　　　　　　Code NU2-22

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			242	(534)
Environmental Control			17	(38)
Guidance, Navigation, Stabilization			40	(88)
Propulsion*			1,752	(3,863)
Propellant	1,521	(3,353)		
Subsystem Dry	231	(510)		
Attitude Control (Mass Expulsion)			20	(43)
Propellant	10	(21)		
Subsystem Dry	11	(22)		
Telemetry, Tracking, Command			57	(126)
Electrical**			156	(344)
Batteries, Conversion	91	(200)		
Conditioning				
Distribution	56	(124)		
Pyrotechnics	9	(20)		
Mission Equipment			1,114	(2,455)
Electronics	48	(105)		
Capsule - Lander (See following page)	1,066	(2,350)		
Total Weight - Dry			1,867	(4,117)
Total Weight - Including Expendables			3,398	(7,491)
Adapter			68	(149)
Launch Weight			3,466	(7,640)

Comments: Weights based on informal JPL data

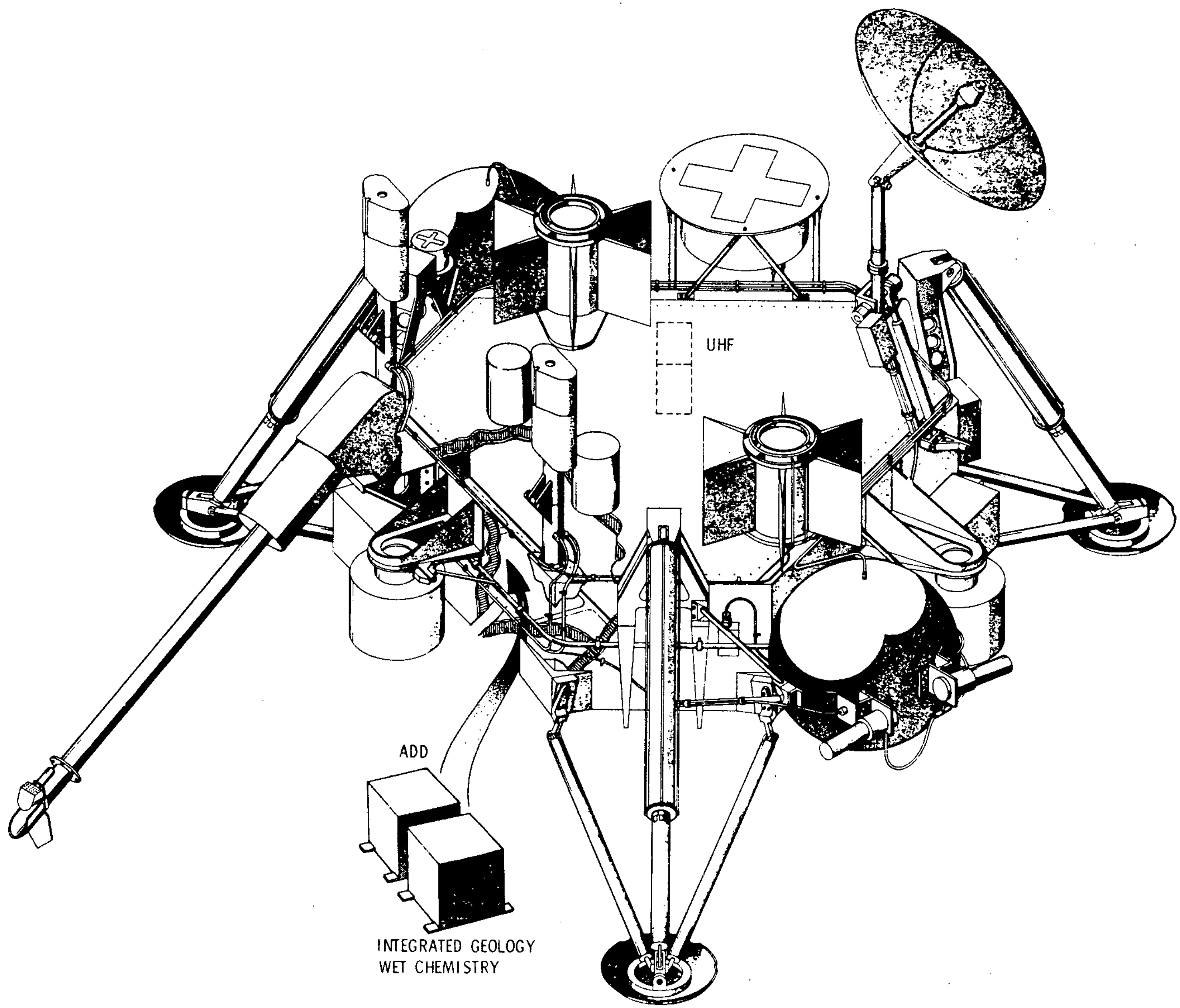
*Propulsion weights do not represent 1979 launch

**200 W

WEIGHTS (Capsule - Lander Only) Code NU2-22

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			432	(953)
Basic Structure and Reentry Shield	381	(840)		
Decelerator-aero	51	(113)		
Environmental Control			42	(93)
Guidance, Navigation, Stabilization			61	(134)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			257	(566)
Propellant	177	(391)		
Subsystem Dry	79	(175)		
Telemetry, Tracking, Command			84	(185)
Electrical			134	(295)
Batteries, Conversion, Conditioning *	78	(171)		
Distribution	37	(82)		
Pyrotechnics	19	(42)		
Mission Equipment			56	(124)
Total Weight - Dry			889	(1,959)
Total Weight - Including Expendables			1,066	(2,350)
Adapter				
Launch Weight				

Comments: *70 W - Radioisotope Thermoelectric Generator (RTG)



Nominal Direct Derivative Payload Configuration

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PAYLOAD DATA SHEET

TITLE: Mars Rover

AGENCY: NASA/OSS

CODE: NU2-23

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Visually characterize sites, search for living organisms and organic compounds, and study atmosphere, meteorology, and seismology on Mars over a large surface area at several sites

Spacecraft Description: Semi-autonomous wheeled vehicle encased in a Viking aeroshell for Mars entry and landing; Rover deploys various autonomous long-lived experiment packages

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Surface travel of 145-434 km (90 to 270 mi), stopping at several pre-planned sites

Launch Window: 20 days

Initial Launch Date: 1986 yr   No. of Satellites in System: 1

System Expected Lifetime: 1 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 11,552 m/sec (37,900 ft/sec)

Satellite Weight: 2,517 kg (5,548 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 4.9 m (16.0 ft) (vol) 51.2 m^3 (1,809.6 ft^3)

General Comments: Follow-on to Viking 1979

See Ref. 13.

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MISSION EQUIPMENT Code NU2-23

Weight: Lander - 449 kg (1,100 lb) Power: 100 W

Type of Experiment(s): See Mission Objectives. Also, orbiter may conduct limited scientific experimentation

Purpose of Experiment(s): Search for life and describe physical, chemical, and magnetic properties

Type of Sensor(s): IR radiometer, mass spectrometer, atmospheric/meteorological sensors, seismology sensors, TV imagers, soil analyzers

Unique Sensor Requirements and Technology Status: State-of-the-art follow-on from Viking 1979

Environmental Requirements: Extreme temperatures, aerodynamic loads, and dust accumulation

Data Processing and Transmission Requirements: Central data system

Attitude Control and Pointing Accuracy Requirements: $\pm 2^{\circ}$ for S-band, $\pm 1/2^{\circ}$ for X-band antenna, earth tracking

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NU2-23

Unique Structural Requirements: Six-wheeled vehicle (orbiter similar to Viking orbiter)

Environmental Control Requirements: Passive and semi-active

Guidance and Navigation Requirements: Ground-commanded travel among pre-selected sites at 0.4 km/hr (0.24 mi/hr) without live TV imaging; requires obstacle-avoidance computing

Propulsive Requirements: Electric motor in each wheel

Type Propellant: ______ **Thrust:** ______

Orbit Adjust: ______ **Total Impulse:** ______ **kg-sec** (______ **lb-sec)**

Apogee Kick Motor: ______

Attitude Control: Gyrocompass, odometer, landmark backup

Pointing Accuracy: $\pm 1/2$ deg for antenna **Pointing Direction:** Earth

Tracking, Telemetry and Command Requirements: S-band, X-band

Antennas: 1.0 m (3.3 ft) circular high-gain antenna; also 1 low-gain for S-band reception

Computers: ______ **Commands:** ______

Type of Electrical Power System: 2 RTGs and 2 batteries

Average Power: 280 W **Peak Power:** 360 W

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-23

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______

Visits: NA

No. of Visits per Year: ______

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain ______ Operate ______

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No X Desirable ______

Fxpected Maintenance Philosophy: ______

General comments on gains that can be ontained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS (orbiter with lander) Code NU2-23

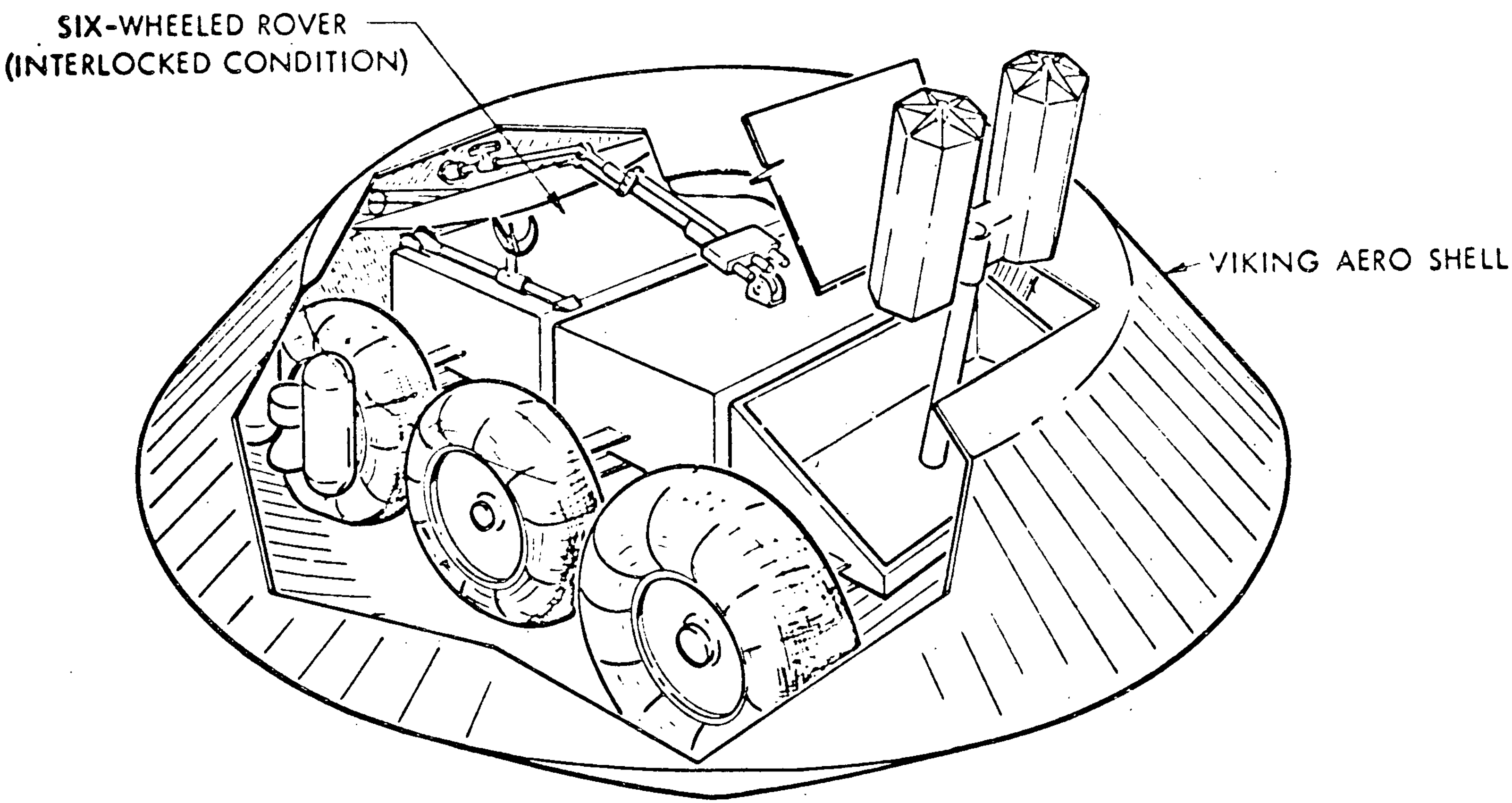
Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			242	(534)
Environmental Control			17	(38)
Guidance, Navigation, Stabilization			40	(88)
Propulsion			1,438	(3,170)
Propellant	1,247	(2,750)		
Subsystem Dry	191	(420)		
Attitude Control (Mass Expulsion)			20	(43)
Propellant	10	(21)		
Subsystem Dry	10	(22)		
Telemetry, Tracking, Command			57	(126)
Electrical			156	(344)
Batteries, Conversion	91	(200)		
Conditioning				
Distribution	56	(124)		
Pyrotechnics	9	(20)		
Mission Equipment			547	(1,205)
Lander	499	(1,100)		
Electronics	48	(105)		
Total Weight - Dry			1,260	(2,777)
Total Weight - Including Expendables			2,517	(5,548)
Adapter			68	(150)
Launch Weight			2,585	(5,698)

Comments: ____

WEIGHTS (lander only) Code NU2-23

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			154	(340)
Environmental Control			14	(30)
Guidance, Navigation, Stabilization			14	(31)
Propulsion			70	(153)
Propellant	50	(110)		
Subsystem Dry	20	(43)		
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			92	(203)
Electrical*			108	(239)
Batteries	30	(66)		
Conversion Conditioning	10	(23)		
Distribution	7	(15)		
RTG (2)	61	(135)		
Mission Equipment			45	(100)
Total Weight - Dry			446	(986)
Total Weight - Including Expendables			496	(1,096)
Adapter				
Launch Weight				

Comments: *2 (140 W) RTGs



Mars Roving Vehicle Entry Configuration (Viking Adaptation)

PAYLOAD DATA SHEET

TITLE: Venus Pioneer

AGENCY: NASA/OSS

CODE: NU2-24

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine 1) upper atmosphere and ionosphere structure, 2) interaction of solar wind with Venus ionosphere and magnetic field, 3) surface and atmospheric characteristics on a planetary scale by remote sensing, 4) gravitational field

Spacecraft Description: Bus with science payload plus one large and three small probes

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:

Launch Window: 20 days

Initial Launch Date: 1976 yr

No. of Satellites in System: 1

System Expected Lifetime: 1 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 11,765 m/sec (38,600 ft/sec)

Satellite Weight: 399 kg (878 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 4.6 m (15.0 ft) (vol) 33.4 m^3 (1,178.1 ft^3)

General Comments: Four missions are planned from 1976 to 1980. This data sheet describes the 1980 mission which is planned as a single probe mission. See Ref. 14.

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MISSION EQUIPMENT

Code NU2-24

Weight: (See weights table.) kg (____ lb) Power: ____ W

Type of Experiment(s): To provide data leading toward the understanding of the coupling between the earth's atmosphere and our planet's rotation

Purpose of Experiment(s): Last in a series of probes and orbiters to study Venus's physical properties

Type of Sensor(s): Pressure, temperature, neutral particle mass, thermal radiation, wind, humidity, and altitude

Unique Sensor Requirements and Technology Status:

Environmental Requirements: Venus's environment

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NU2-24

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Semi-passive

Guidance and Navigation Requirements: Elaborate command and programming system, midcourse corrections, on-board firing of retro motor for orbit insertion and orbit trim

Propulsive Requirements: 3 midcourse corrections, orbit insertion maneuver (ΔV = 1,804 - 2,408 m/sec [5,920 - 7,900 ft/sec]) and apoapsis maneuver

Type Propellant: N_2H_4 Thrust: 6 thrusters (0.4 to 1.4 lb) 1.7 to 6.0 N each

Orbit Adjust: Yes Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: Spin stabilized

Pointing Accuracy: ______ Pointing Direction: Perpendicular to sun line

Tracking, Telemetry and Command Requirements: Direct link to DSN

Antennas: ______

Computers: ______ Commands: ______

Type of Electrical Power System: "Oriented" solar array plus battery

Average Power: 65 W Peak Power: 125 W

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-24

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

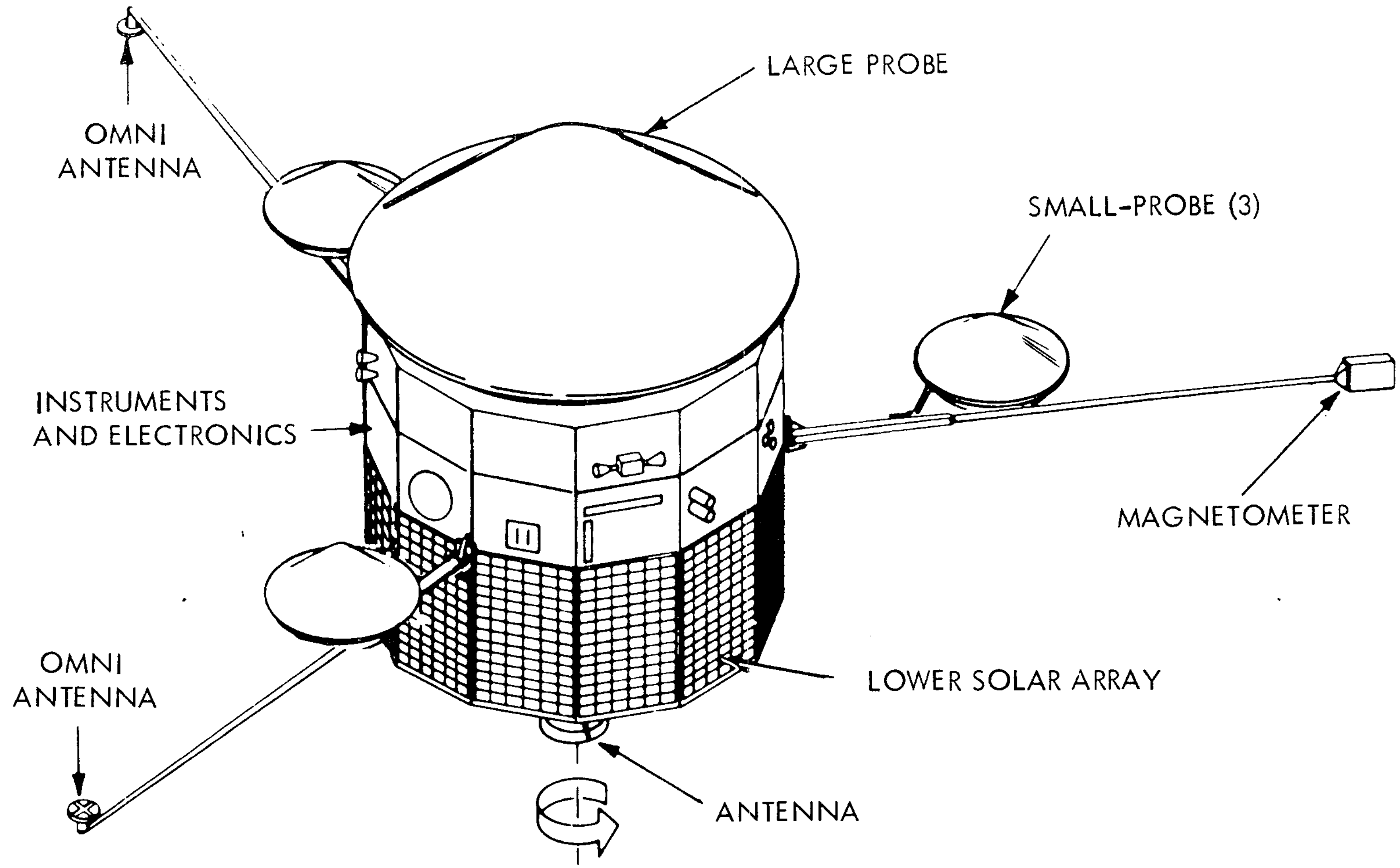
Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			50	(110)*
Environmental Control			5	(10)*
Guidance, Navigation, Stabilization			14	(30)*
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion)			34	(75)*
Propellant	25	(55)		
Subsystem Dry	9	(20)		
Telemetry, Tracking, Command			25	(55)*
Electrical (125 W) Batteries (Oriented Conversion solar Conditioning array) Distribution			21	(46)*
Mission Equipment			250	(552)
Small probes (3)	68	(150)		
Large probe	174	(384)		
Science payload	8	(18)		
Total Weight - Dry			374	(823)
Total Weight - Including Expendables			399	(878)
Adapter			20	(44)
Launch Weight			419	(922)

Comments: *Pioneer total weight - 148 kg (326 lb)



Venus Pioneer - Possible Multiple Probe Configuration

PAYLOAD DATA SHEET

TITLE: Venus Radar Mapper AGENCY: NASA/OSS

CODE: NU2-25

PROGRAM: Planetary Exploration COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Surface mapping of Venus to a resolution of 100 m (328 ft) using radar from orbiting spacecraft

Spacecraft Description: Synthetic aperture radar system

Periapsis km (n mi)/Apoapsis km (n mi)/Inclination deg: 500 (270)/ 500 (270)/ polar Venus orbit

Launch Window: 20 days

Initial Launch Date: 1984 yr No. of Satellites in System: 2

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 11,765 m/sec (38,600 ft/sec)

Satellite Weight: 944 kg (2,081 lb)

Satellite Launch Dimensions: (diam) 3.0 m (length) 3.7 m (vol) 26.7 m^3

(10.0 ft) (12.0 ft) (942.5 ft^3)

General Comments: Planetary sterilization is required

See Ref. 15

MISSION EQUIPMENT Code NU2-25

Weight: 181 kg (400 lb) Power: 420 W

Type of Experiment(s): Use radar to map Venus surface to a ground resolution of 100 to 200 m (328 to 656 ft)

Purpose of Experiment(s): Map surface of Venus with radar from an orbiting spacecraft

Type of Sensor(s): Synthetic aperture radar, 35 m (115 ft) long

Unique Sensor Requirements and Technology Status: High (3×10^5 bps) data transfer rates

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 2.5×10^5 bps

Attitude Control and Pointing Accuracy Requirements: 30 arc min pointing accuracy

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NU 2-25

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Passive system

Guidance and Navigation Requirements: Horizon and sun sensors

Propulsive Requirements: Ballistic transfer with mid-course and chemical retro motor for Venus orbit capture

Type Propellant: Hydrazine and solid Thrust: ________

Orbit Adjust: ________ Total Impulse: ________ kg-sec (________ lb-sec)

Apogee Kick Motor: ________

Attitude Control: 3-axis, wheels

Pointing Accuracy: 30 arc min Pointing Direction: Venus

Tracking, Telemetry and Command Requirements: 2.5×10^5 bps, 40 W X-band

Antennas: Paraboloid, 2.7 m (9 ft), X-band, 2 X 10 m (6.6 X 33 ft) radar

Computers: 10^9 bits storage Commands: ________

Type of Electrical Power System: Solar array and battery

Average Power: 700 W Peak Power: ________

Unique Interstage/Adapter Requirements: ________

SHUTTLE INTERFACE   Code NU2-25

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment ____

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

On-orbit checkout

WEIGHTS

Code NU 2-25

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			123	(270)
Environmental Control			19	(42)
Guidance, Navigation, Stabilization			15	(33)
Propulsion			340	(750)
Propellant (Retro)	313	(690)		
Subsystem Dry	27	(60)		
Attitude Control (Mass Expulsion)			77	(170)
Propellant	54	(120)		
Subsystem Dry	23	(50)		
Telemetry, Tracking, Command			66	(146)
Electrical (5 RTGs) Batteries Conversion Conditioning Distribution			123	(270)
Mission Equipment Radar (Synthetic Aperture)			181	(400)
Total Weight - Dry			577	(1,271)
Total Weight - Including Expendables			944	(2,081)
Adapter			47	(104)
Launch Weight			991	(2,185)

Comments: Weights from reference document

PAYLOAD DATA SHEET

TITLE: Venus Large Lander AGENCY: NASA/OSS

CODE: NU 2-26

PROGRAM: Planetary Exploration COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Obtain data on properties and environment of the Venus atmosphere and surface, and map the surface

Spacecraft Description: Rough landing with impact limiter and several hours surface lifetime

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 2,500 (1,350) periapsis flyby mission

Launch Window: 16 days

Initial Launch Date: 1989 yr No. of Satellites in System: 2

System Expected Lifetime: 1/2 yr cruise, 1 hr surface

Satellite Mean Mission Duration: 1/2 yr cruise, 1 hr surface

Satellite Desired Availability: NA %

Characteristic Velocity: 11,765 m/sec (38,600 ft/sec)

Satellite Weight: 530 kg (1,169 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 3.0 m (10.0 ft) (vol) 22.2 m^3 (785.0 ft^3)

General Comments: Planetary sterilization required.
See Ref. 16

MISSION EQUIPMENT Code NU2-26

Weight: 282 kg (622 lb) Power: 14 W, lander; 80 W, spacecraft

Type of Experiment(s): Perform experiment during cruise, encounter, atmospheric entry of capsule, and landed capsule

Purpose of Experiment(s): Analysis of surface properties and environment, measurements of atmospheric properties and mapping of surface

Type of Sensor(s): Proton telescope, energy analyzer, spectrometers, and magnetometer in spacecraft; charged particle, pressure sensor, water vapor sensor, spectrometers, photometer, and accelerometers in lander

Unique Sensor Requirements and Technology Status: Atmospheric entry capsule heat shield materials and atmosphere descent sensors in lander

Environmental Requirements: Entry of Venus atmosphere and landed atmosphere ($700^{\circ}K$, 750 psia); lander sterilization

Data Processing and Transmission Requirements: 4 kbps from spacecraft and 10 bps from lander to earth; 10^8 bits storage in spacecraft

Attitude Control and Pointing Accuracy Requirements: $\pm$ 2 deg pointing

Propulsion Requirements: Midcourse correction and Venus retro

SUPPORTING SUBSYSTEMS Code NU2-26

Unique Structural Requirements: Spacecraft - exo type, lander - endo type; impact limiter; no parachutes required

Environmental Control Requirements: Spacecraft - semi-active, louvers; lander - passive; hermetically sealed and insulated shell contains equipment

Guidance and Navigation Requirements: Planet tracker, sun sensor, and canopus tracker, gyros

Propulsive Requirements: 40 m/sec (131 ft/sec) midcourse correction; Venus orbit retro (ΔV = 1,302 - 1,905 m/sec [4,270 - 6,250 ft/sec])

Type Propellant: Solid rockets in lander, N_2H_4 for midcourse correction Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: Spin-up of capsule/lander; yo-yo despin; 3-axis, cold gas "bang-bang" in spacecraft

Pointing Accuracy: $\pm$ 2 deg Pointing Direction: Earth/Venus

Tracking, Telemetry and Command Requirements: S-band

Antennas: Low and high gain, 1.2 m (4 ft), S-band

Computers: Central computer Commands: ______

Type of Electrical Power System: Battery in lander, "oriented" solar array and battery in spacecraft

Average Power: 275 W (39 W in lander) Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-26

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical ______

Environment ______

Checkout X

Other ______

Visits:

No. of Visits per Year: None

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain ______ Operate ______

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No X Desirable ______

Expected Maintenance Philosophy: ______

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			55	(122)
Structure	30	(66)		
Actuator	3	(6)		
Steriliz. Can	23	(50)		
Environmental Control			14	(30)
Propulsion				
Propellant	14	(30)	23	(50)
Subsystem Dry	9	(20)		
Attitude Control (Mass Expulsion)			35	(78)
Propellant	2	(5)		
Subsystem Dry	33	(73)		
Telemetry, Tracking, Command			86	(190)
Electrical (275 W)			35	(77)
Mission Equipment			282	(622)
Cruise Science	20	(45)		
Capsule Lander	127	(280)		
Science Elec.	23	(50)		
Microwave	30	(67)		
UVS Platform	14	(30)		
Contingency	68	(150)		
Total Weight - Dry			514	(1,134)
Total Weight - Including Expendables			530	(1,169)
Adapter			22	(48)
Launch Weight			552	(1,217)

Comments: Weights from p. 330 of reference document.

WEIGHTS (lander only) Code NU2-26

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			57	(125)
Environmental Control			25*	(56)*
Guidance, Navigation, Stabilization			3	(7)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			3*	(6)*
Telemetry, Tracking, Command			10	(22)
Electrical Batteries Conversion Conditioning Distribution			14	(30)
Mission Equipment			15	(34)
Total Weight - Landed			99	(218)
Total Weight - Including Expendables & Ejectables*			127	(280)
Adapter				
Launch Weight				

Comments: ______

PAYLOAD DATA SHEET

TITLE: Mercury Orbiter

AGENCY: NASA/OSS

CODE: NU2-27

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine characteristics of surface and atmosphere of Mercury; mass, shape, and size of planet; magnetic field; and interaction of solar wind with planet

Spacecraft Description: Satellite uses solar electric propulsion (SEP)*

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, 500 (270)/500 270/0^{o} Mercury orbit; 370-day transit trajectory

Launch Window: NA days

Initial Launch Date: 1987 yr No. of Satellites in System: 2

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 12,900 m/sec (42,300 ft/sec)

Satellite Weight:** 2,343 kg (5,166 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 7.6 m (25.0 ft) (vol) 80.1 m^3 (2,827.4 ft^3)

General Comments: *Ballistic type mission would require Saturn-class launch vehicle. **Includes SEP and retro-propulsion.

See Ref. 17

MISSION EQUIPMENT Code NU2-27

Weight: 70 kg (154 lb) Power: ______ W

Type of Experiment(s): Define the composition, topography, geological structure, and temperature variation of the surface of Mercury

Purpose of Experiment(s): Obtain information on planet nearest sun on the conditions and dynamics in that region and develop a greater understanding of the solar system

Type of Sensor(s): Slow-scan vidicons, IR imager, UV spectrometer

Unique Sensor Requirements and Technology Status: SEP and high temperature solar panels

Environmental Requirements: High temperatures near Mercury

Data Processing and Transmission Requirements: 16 kbps and two tape recorders

Attitude Control and Pointing Accuracy Requirements: ______

Propulsion Requirements: 15 kW SEP system with 6 Mercury ion thrusters of 2,500 sec specific impulse - four operate and two on standby

SUPPORTING SUBSYSTEMS Code NU2-27

Unique Structural Requirements: Exo

Environmental Control Requirements:

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: SEP for travel to Mercury; chemical retro propulsion

Type Propellant: GN_2 for ACS Thrust: 15 kW SEP at I_{sp} = 2,500 sec

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor:

Attitude Control: 3-axis, thrusters

Pointing Accuracy: ______ Pointing Direction:

Tracking, Telemetry and Command Requirements: S-band

Antennas: 2.7 m (9 ft) rigid

Computers: ______ Commands:

Type of Electrical Power System: Solar array and batteries

Average Power: 300W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE　　Code NU2-27

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment ___

Checkout X

Other ___

Visits:

No. of Visits per Year: None

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish ___ Replace ___

Maintain ___ Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS

Code NU2-27

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			120*	(265)*
Environmental Control			15*	(33)*
Guidance, Navigation, Stabilization			0	(0)
Propulsion - Retro			390	(860)
Propellant	350	(772)		
Subsystem Dry	40	(88)		
Attitude Control (Mass Expulsion)			50*	(110)*
Propellant	35	(77)		
Subsystem Dry	15	(33)		
Telemetry, Tracking, Command			85*	(187)*
Electrical (300 W) Batteries Conversion Conditioning Distribution (Solar arrays)			100*	(221)*
Mission Equipment			70*	(154)*
SEP			1,513	(3,336)
Stage	450**	(992)**		
Propellant	1,032	(2,276)		
Tanks	31	(68)		
Total Weight - Dry			926	(2,041)
Total Weight - Including Expendables			2,343	(5,166)
Adapter 5%			117	(258)
Launch Weight			2,460	(5,424)

Comments: *payload = 440 kg (970 lb)

**solar array = 250 kg (552 lb); thruster arrays = 125 kg (275 lb); power conditioning = 75 kg (165 lb)

PAYLOAD DATA SHEET

TITLE: Pioneer-Jupiter Orbiter

AGENCY: NASA/OSS

CODE: NU2-28

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine interaction of Jupiter and solar media; define fields and RF radiation source; determine composition of the Jovian atmosphere; define the solar/galactic flux interactions with the planet; determine whether the interior of the planet is liquid or solid

Spacecraft Description: Spin-stabilized spacecraft, derivative of Pioneer F&G flyby configuration

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, 1.1 R_J periapsis, Jupiter equatorial orbit (14-day period)

Launch Window: 20 days

Initial Launch Date: 1978 yr

No. of Satellites in System: 1

System Expected Lifetime: 4 yr

Satellite Mean Mission Duration: 4 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 15,057 m/sec (49,400 ft/sec)

Satellite Weight: 884 kg (1,948 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 6.1 m (20.0 ft) (vol) 44.5 m^3 (1,570.8 ft^3)

General Comments: Planetary sterilization required. See Ref. 18

MISSION EQUIPMENT Code NU2-28

Weight: 54 kg (120 lb) Power: 60 W

Type of Experiment(s): To assist in determining the possible primordial state of the planet, which may be related to the early history of the solar system

Purpose of Experiment(s): Acquire knowledge of atmosphere composition, field and RF radiation, and interaction with solar media, which will provide greater insight on the energy balance

Type of Sensor(s): TV imager, IR radiometer, UV spectrometers; particle, fields, RF, and atmosphere sensors

Unique Sensor Requirements and Technology Status:

Environmental Requirements: Radiation hardening

Data Processing and Transmission Requirements: 16 kbps at X-band; and 2 kbps at S-band (at 5 A.U.); 310 k-bits storage

Attitude Control and Pointing Accuracy Requirements: 1 deg pointing

Propulsion Requirements: Midcourse ΔV, spin control, and retro into Jupiter orbit

SUPPORTING SUBSYSTEMS Code NU2-28

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive (louver), radio isotope heater (1 W), radiation hardening

Guidance and Navigation Requirements: Stellar and solar reference

Propulsive Requirements: Total propulsion capability 875 m/sec (2870 ft/sec); Jupiter ΔV = 399-500 m/sec (1310-1640 ft/sec)

Type Propellant: Hydrazine Thrust: 0.227 kg (0.5 lb) attitude control; 22.7 kg (50 lb) ΔV change

Orbit Adjust: 100 m/sec (328 ft/sec) Total Impulse: 24,948 kg-sec (55,000 lb-sec)

Apogee Kick Motor: none Spin-up: 4.8 rpm

Attitude Control: Spin, nutation damper

Pointing Accuracy: 1 deg Pointing Direction: Jupiter/earth

Tracking, Telemetry and Command Requirements: S- and X-band

Antennas: 3, low/med/high gain, 2.7 m (9 ft), S-band

Computers: 300,000 bit storage Commands:

Type of Electrical Power System: RTG/battery

Average Power: 260 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NU2-28

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: none

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

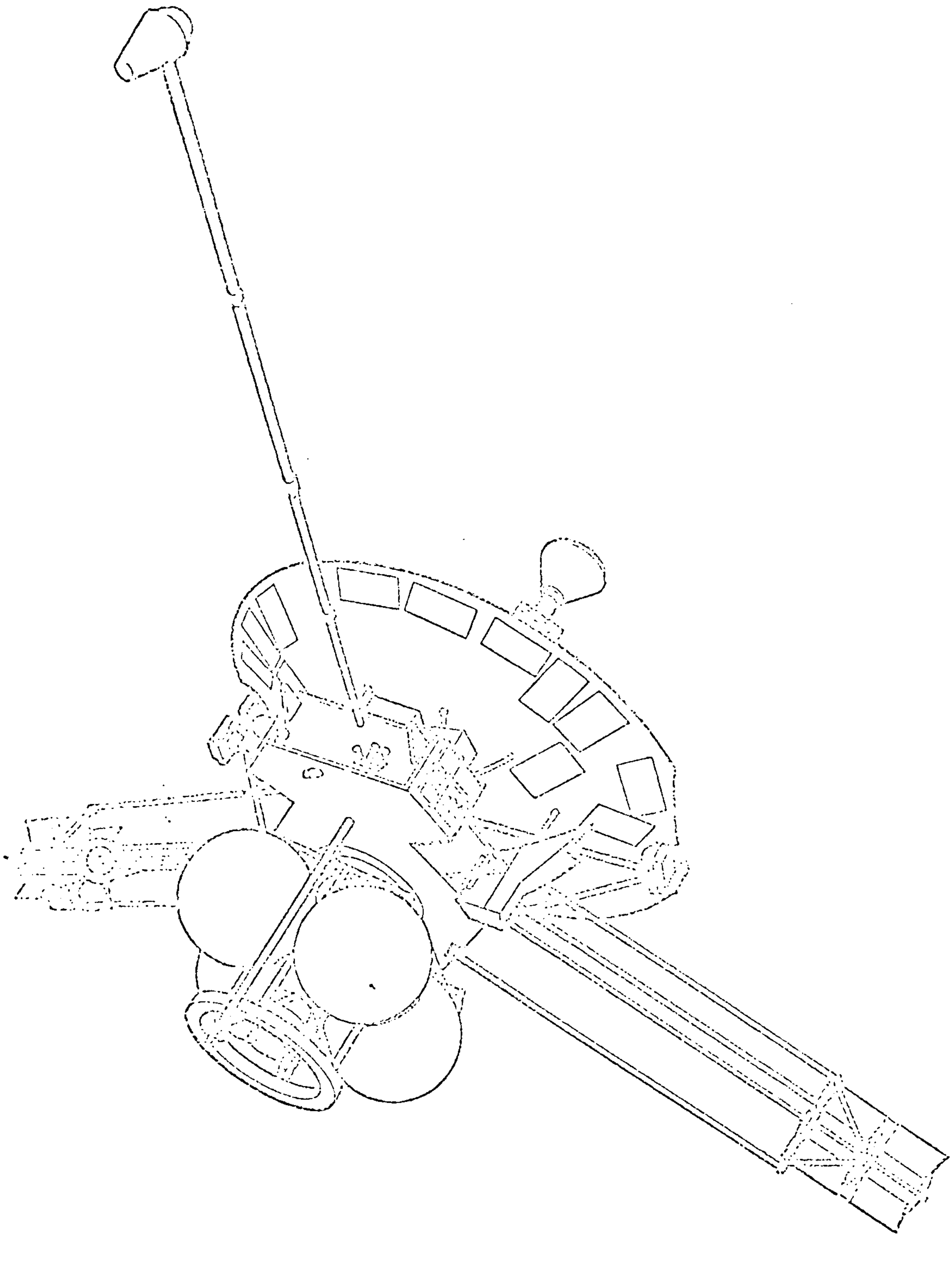
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

 Code NU2-28

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			50	(110)
Environmental Control			5	(10)
Guidance, Navigation, Stabilization			14	(30)
Propulsion			564	(1,243)
Propellant	454	(1,000)		
Subsystem Dry	110	(243)		
Attitude Control (Mass Expulsion)			54	(120)
Propellant	36	(80)		
Subsystem Dry	18	(40)		
Telemetry, Tracking, Command			25	(55)
Electrical (260 W) Batteries, Conversion, Conditioning } RTG; Distribution			118	(260)
Mission Equipment			54	(120)
Total Weight - Dry			394	(868)
Total Weight - Including Expendables			884	(1,948)
Adapter			18	(40)
Launch Weight			902	(1,988)

Comments: ___

C-3



Pioneer-Jupiter Orbiter (Typical)

200

PAYLOAD DATA SHEET

TITLE: Mariner-Jupiter/Uranus Flyby AGENCY: NASA/OSS

CODE: NU2-29

PROGRAM: Planetary Exploration COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Study Jupiter and Uranus concerning environment, atmosphere, surface, body characteristics, and their satellites; study the Red Spot of Jupiter

Spacecraft Description: 3-axis stabilized, Mariner class developed for the Jupiter/Saturn 1977 mission

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, fly by Jupiter and Uranus, then escape solar system

Launch Window: NA days

Initial Launch Date: 1979 yr No. of Satellites in System: 2

System Expected Lifetime: 6 yr

Satellite Mean Mission Duration: 6 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 15,621 m/sec (51,250 ft/sec)

Satellite Weight: 699 kg (1,540 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 4.6 m (15.0 ft) (vol) 33.4 m^3 (1,178.1 ft^3)

General Comments:

MISSION EQUIPMENT Code NU2-29

Weight: 70 kg (154 lb) Power: ________ W

Type of Experiment(s): Determine physical properties, dynamics, and composition of the planets' atmospheres, surface features, thermal regimes, and energy balances

Purpose of Experiment(s): Investigation of the marked differences between the outer planets and the more familiar terrestrial planets could lead to greater understanding of planetary evolution

Type of Sensor(s): TV, IR spectrometer, UV radiometer and spectrometer, magnetometer, trapped radiation detectors, solar wind probe

Unique Sensor Requirements and Technology Status: Utilizes Mariner spacecraft developed for Jupiter/Saturn 1977 mission

Environmental Requirements: ________

Data Processing and Transmission Requirements: ________

Attitude Control and Pointing Accuracy Requirements: ________

Propulsion Requirements: ________

SUPPORTING SUBSYSTEMS Code NU 2-29

Unique Structural Requirements: Exo

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: Midcourse correction

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 3-axis

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S- and X-band

Antennas: Parabolic high-gain

Computers: ______ Commands: ______

Type of Electrical Power System: RTGs and batteries

Average Power: 300 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-29

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No x Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Code NU2-29

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			91	(200)
Environmental Control			14	(30)
Guidance, Navigation, Stabilization			32	(70)
Propulsion			227	(500)
Propellant	181	(400)		
Subsystem Dry	45	(100)		
Attitude Control (Mass Expulsion)			45	(100)
Propellant	32	(70)		
Subsystem Dry	14	(30)		
Telemetry, Tracking, Command			45	(100)
Electrical, RTG			175	(386)
Batteries	136	(300)		
Conversion				
Conditioning				
Distribution	39	(86)		
Mission Equipment			70	(154)
Total Weight - Dry			486	(1,070)
Total Weight - Including Expendables			699	(1,540)
Adapter			35	(77)
Launch Weight			734	(1,617)

Comments: ______________________________

MISSION EQUIPMENT

Code NP2-20

Weight: 30 kg (66 lb) Power: 25 W

Type of Experiment(s): Explore the region that has not been explored by interplanetary flights.

Purpose of Experiment(s): Map interplanetary magnetic field, solar wind, high energy charged particles; and search for asteroids and determine their size, mass, flux, and orbital data.

Type of Sensor(s): Meteoroid detector, magnetometer, particle detectors, cosmic ray telescope, radiometer, and UV photometer

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Magnetically clean satellite to minimize interference of the magnetometer measurement

Data Processing and Transmission Requirements: 50 kbit storage, 1 kbps from Jupiter distance

Attitude Control and Pointing Accuracy Requirements: 1 deg

Propulsion Requirements: Midcourse correction and attitude control

PAYLOAD DATA SHEET

TITLE: Pioneer-Jupiter Probe AGENCY: NASA/OSS

CODE: NU2-30

PROGRAM: Planetary Exploration COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine Jupiter's atmospheric structure, elemental and isotropic abundances, and cloud characteristics

Spacecraft Description: Pioneer spacecraft serves as data relay for probe

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, spacecraft periapsis at 1.3 R_j in flyby

Launch Window: 20 days

Initial Launch Date: 1982 yr No. of Satellites in System: 2

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 15,220 m/sec (49,900 ft/sec)

Satellite Weight: 360 kg (794 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 5.2 m (17.0 ft) (vol) 37.8 m^3 (1,335.2 ft^3)

General Comments: See Ref. 19

MISSION EQUIPMENT Code NU2-30

Weight: 88 kg (194 lb) Power: ______ W

Type of Experiment(s): Determine the composition and physical state of the atmosphere and the hydrogen to helium ratio

Purpose of Experiment(s): To study the origin and evolution of the solar system and enhance the understanding of the early history of the solar system

Type of Sensor(s): Probe - temperature and pressure sensors, mass spectrometer, accelerometer

Unique Sensor Requirements and Technology Status: High g-loads, aero heating, and radiation levels; long shelf-life

Environmental Requirements: High heating and radiation levels

Data Processing and Transmission Requirements: ______

Attitude Control and Pointing Accuracy Requirements: ______

Propulsion Requirements: ______

SUPPORTING SUBSYSTEMS — Code: NU2-30

Unique Structural Requirements: Exo

Environmental Control Requirements: Passive; heat shield on probe

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements:

Type Propellant: Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: Spin-stabilized, thrusters

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: S-band

Antennas: 2.7 m (9.0 ft) parabolic dish

Computers: Commands:

Type of Electrical Power System: RTGs and batteries

Average Power: 400 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NU2-30

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical X

Environment ______

Checkout X

Other ______

Visits:

No. of Visits per Year: None

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain ______ Operate ______

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No X Desirable ______

Expected Maintenance Philosophy: ______

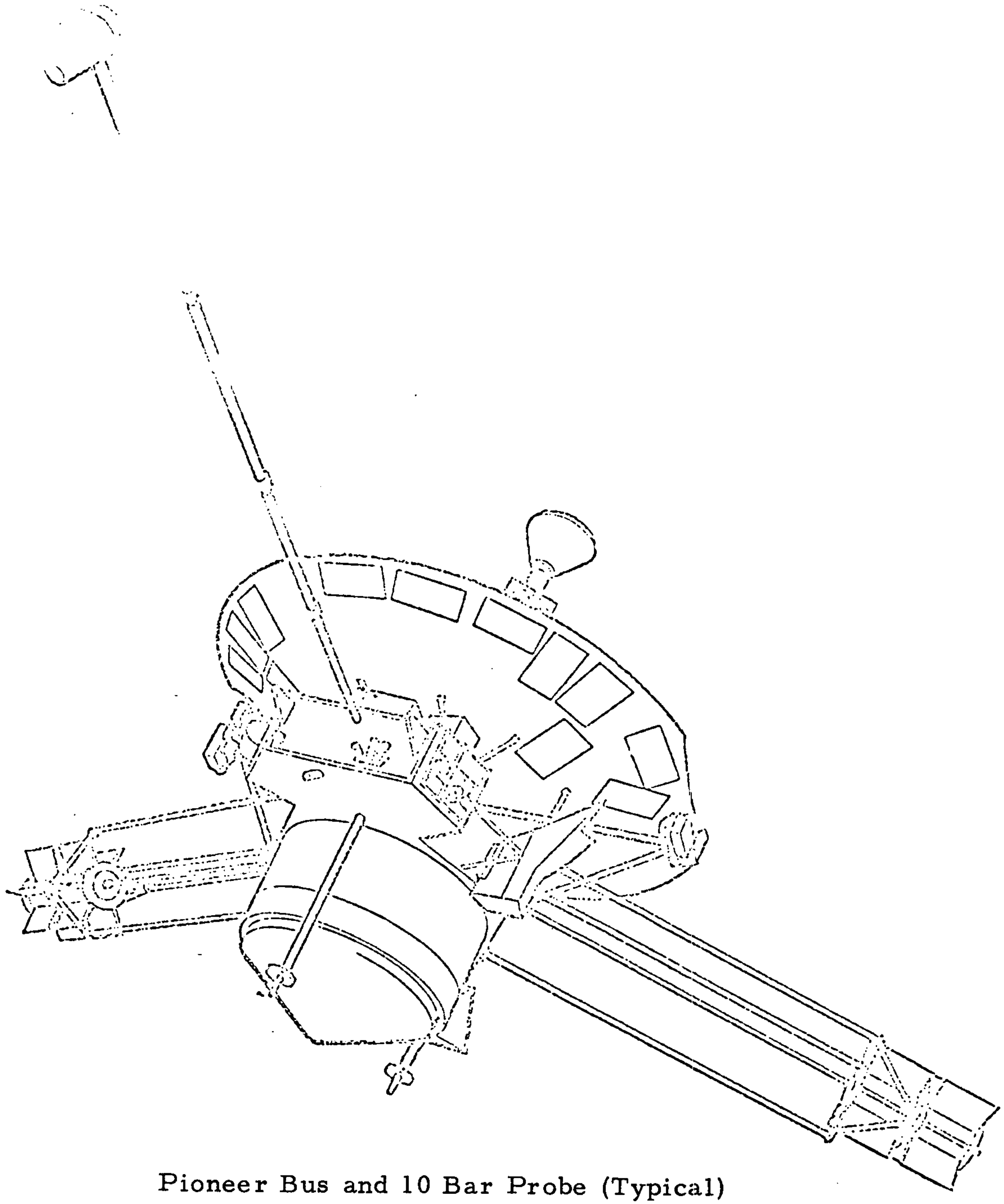
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS

Code NU2-30

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			41*	(90)*
Environmental Control			2 *	(5)*
Guidance, Navigation, Stabilization			11 *	(25)*
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			32 *	(70)*
Propellant	23	(50)		
Subsystem Dry	9	(20)		
Telemetry, Tracking, Command			23 *	(50)*
Electrical, RTGs			163 *	(360)*
Batteries (400 W)				
Conversion				
Conditioning				
Distribution				
Mission Equipment				
Probe			88	(194)
Experiments	16	(35)		
Structure	12	(27)		
Equip. Supports	20	(44)		
Heat Shield	40	(88)		
Total Weight - Dry			337	(744)
Total Weight - Including Expendables			360	(794)
Adapter			18	(40)
Launch Weight			378	(834)

Comments: * spacecraft total weight - 272 kg (600 lb)



Pioneer Bus and 10 Bar Probe (Typical)

PAYLOAD DATA SHEET

TITLE: Pioneer-Saturn Probe

AGENCY: NASA/OSS

CODE: NU2-31

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Define Saturn's atmospheric structure, composition, and dynamic processes underway in the atmosphere

Spacecraft Description: Pioneer type spacecraft, flyby spacecraft with probe to enter Saturn atmosphere

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary flyby and reentry probe

Launch Window: 20 days

Initial Launch Date: 1984 yr

No. of Satellites in System: 2

System Expected Lifetime: 4 yr

Satellite Mean Mission Duration: 4 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 14,722 m/sec (48,300 ft/sec)

Satellite Weight: 386 kg (850 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 5.2 m (17.0 ft) (vol) 37.8 m^3 (1,335.2 ft^3)

General Comments:

MISSION EQUIPMENT Code NU2-31

Weight: 141 kg (310 lb) Power: ______ W

Type of Experiment(s): Determine the composition and structure of the Saturn atmosphere

Purpose of Experiment(s): To provide input to studies on the origin and evolution of the solar system, and the evolutionary development of planetary atmospheres

Type of Sensor(s): Small reentry probe, temperature, pressure, mass spectrometer, and accelerometer

Unique Sensor Requirements and Technology Status: 700 g's reentry decelerations

Environmental Requirements: High reentry g's

Data Processing and Transmission Requirements: 50 k-bit storage

Attitude Control and Pointing Accuracy Requirements: ______

Propulsion Requirements: Midcourse corrections

SUPPORTING SUBSYSTEMS Code NU2-31

Unique Structural Requirements: Exo

Environmental Control Requirements: Louvers

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements:

Type Propellant: Hydrazine Thrust: 1 - lb thrusters

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor:

Attitude Control: Spin stabilized, 5 rpm

Pointing Accuracy: ______ Pointing Direction:

Tracking, Telemetry and Command Requirements: S- and X-band

Antennas: 2.7-m (9.0 ft) parabolic dish

Computers: ______ Commands:

Type of Electrical Power System: RTG

Average Power: 120 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NU2-31

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS

Code NU2-31

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			41	(90)
Environmental Control			2	(5)
Guidance, Navigation, Stabilization			11	(25)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			32	(70)
Propellant	23	(50)		
Subsystem Dry	9	(20)		
Telemetry, Tracking, Command			23	(50)
Electrical, RTGs			136	(300)
Batteries (300 W)				
Conversion				
Conditioning				
Distribution				
Mission Equipment			141	(310)
Experiments	27	(60)		
Probe	113	(250)		
Total Weight - Dry			363	(800)
Total Weight - Including Expendables			386	(850)
Adapter 5%			22	(48)
Launch Weight			408	(898)

Comments: ______________________________

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PAYLOAD DATA SHEET

TITLE: Mariner-Jupiter Orbiter

AGENCY: NASA/OSS

CODE: NU2-32

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Comprehensive and detailed investigations of Jupiter, its satellites, atmosphere, fields, and particles

Spacecraft Description: Mariner growth version

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, periapsis 1.1 R_j to 1.4 R_j (14-day period) equatorial

Launch Window: 20 days

Initial Launch Date: 1986 yr

No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 15,057 m/sec (49,400 ft/sec)

Satellite Weight: 1,135 kg (2,500 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 4.9 m (16.0 ft) (vol) 51.2 m^3 (1,809.6 ft^3)

General Comments: See Ref. 20.

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MISSION EQUIPMENT Code NU2-32

Weight: 68 kg (150 lb) Power: 75 W

Type of Experiment(s): Determine energy balance, define the fields and RF radiation sources, define solar/galactic flux interactions with the planets

Purpose of Experiment(s): Determine whether Jupiter is still in the primordial state of development, and provide clues on the origin and formation of the solar system

Type of Sensor(s): TV, photometer, radiometer, spectrometers, magnetometer, RF receiver, trapped radiation detector, absolute photometer, IR imaging radiometer

Unique Sensor Requirements and Technology Status:

Environmental Requirements:

Data Processing and Transmission Requirements: 2,500 bps

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements: Restartable retro-propulsion and midcourse correction engines

SUPPORTING SUBSYSTEMS Code NU2-32

Unique Structural Requirements: Exo, magnesium framework

Environmental Control Requirements: Passive (louvers)

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: Gimballed engine for retro-propulsion

Type Propellant: F_2/N_2H_4 Thrust: 1,340 N (300 lb)

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 3-axis, thrusters

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S- and X-band

Antennas: High-gain 2.7-m (9.0 -ft) parabolic dish, 2 low-gain antennas

Computers: ______ Commands: ______

Type of Electrical Power System: RTGs and batteries

Average Power: 390 W Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-32

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS

Code NU2-32

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			136	(300)
Environmental Control			23	(50)
Guidance, Navigation, Stabilization			34	(75)
Propulsion Retro			499	(1,100)
Propellant	408	(900)		
Subsystem Dry	91	(200)		
Attitude Control (Mass Expulsion)			68	(150)
Propellant	45	(100)		
Subsystem Dry	23	(50)		
Telemetry, Tracking, Command			91	(200)
Electrical, RTGs			216	(475)
RTG (390 W)	147	(324)		
Conversion	32	(70)		
Conditioning	32	(71)		
Distribution	5	(10)		
Mission Equipment			68	(150)
Total Weight - Dry			682	(1,500)
Total Weight - Including Expendables			1,135	(2,500)
Adapter			57	(125)
Launch Weight			1,192	(2,625)

Comments: ______________________________

PAYLOAD DATA SHEET

TITLE: Uranus Probe/Neptune Flyby

AGENCY: NASA/OSS

CODE: NU2-33

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine the mass distribution and magnetic field characteristics of Uranus and Neptune, the characteristics of their atmospheres and radiation belts, and the interaction of the solar wind and galactic radiation with the planets

Spacecraft Description: Mariner class; SEP

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary

Launch Window: 20 days

Initial Launch Date: 1986 yr

No. of Satellites in System: 2

System Expected Lifetime: 12 yr

Satellite Mean Mission Duration: 12 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 17,495 m/sec (57,400 ft/sec)

Satellite Weight:* 2,263 kg (4,990 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 5.2 m (17.0 ft) (vol) 54.4 m^3 (1,922.7 ft^3)

General Comments: *includes SEP

MISSION EQUIPMENT Code NU2-33

Weight: 50 kg (110 lb) Power: ______ W

Type of Experiment(s): Surface features, thermal regimes, energy balance, charged particles, electromagnetic environment, period of rotation, radii, gravitational fields

Purpose of Experiment(s): Study of interplanetary medium and the reaches of space beyond the planetary orbits could provide valuable clues to the development of the solar system

Type of Sensor(s): TV, spectrometers, radiometers, magnetometers, pressures, particle sensors, visual spectrometer and IR radiometer, small probe

Unique Sensor Requirements and Technology Status: SEP

Environmental Requirements:

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements: SEP

SUPPORTING SUBSYSTEMS Code NU2-33

Unique Structural Requirements: Exo

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: SEP

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 3-axis, thrusters

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S-band

Antennas: Parabolic dish

Computers: ______ Commands: ______

Type of Electrical Power System: RTGs and batteries

Average Power: ______ Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-33

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Code NU2-33

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			161	(355)
Environmental Control			20	(45)
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			68	(150)
Propellant	48	(105)		
Subsystem Dry	20	(45)		
Telemetry, Tracking, Command			113	(250)
Electrical			136	(300)
Batteries				
Conversion				
Conditioning				
Distribution	136	(300)		
Mission Equipment			50	(110)
Probe	50	(110)		
SEP			7,715	(3,780)
Stage	450	(992)		
Propellant	1,225	(2,700)		
Tanks	40	(88)		
Total Weight - Dry			990	(2,185)
Total Weight - Including Expendables			2,263	(4,990)
Adapter			91	(200)
Launch Weight			2,354	(5,190)

Comments: ____________________

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PAYLOAD DATA SHEET

TITLE: Mariner-Saturn Orbiter

AGENCY: NASA/OSS

CODE: NU2-34

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine characteristics of Saturn's size, mass, atmosphere, radiation, solar wind effects, and characteristics of its rings

Spacecraft Description: Mariner class; SEP

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary (1.2 to 2.3 Rs with a 15- to 30-day period)

Launch Window: 20 days

Initial Launch Date: 1989 yr

No. of Satellites in System:

System Expected Lifetime: 6 yr

Satellite Mean Mission Duration: 6 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 15,484 m/sec (50,800 ft/sec)

Satellite Weight:* 1,073 kg (2,368 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 5.2 m (17.0 ft) (vol) 54.4 m^3 (1,922.7 ft^3)

General Comments: *includes SEP

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MISSION EQUIPMENT

Code NU2-34

Weight: 9 kg (20 lb) Power: ______ W

Type of Experiment(s): Determine composition and structure of the Saturn atmosphere, internal mass distribution, magnetic field, and magnitude

Purpose of Experiment(s): To determine whether the planet is still in the primordial state of development and gain clues on the origin and formation of the solar system

Type of Sensor(s): TV, radiometer, spectrometers, magnetometers, particle sensors

Unique Sensor Requirements and Technology Status: SEP

Environmental Requirements: Radiation hazard

Data Processing and Transmission Requirements: ______

Attitude Control and Pointing Accuracy Requirements: ______

Propulsion Requirements: ______

SUPPORTING SUBSYSTEMS Code NU2-34

Unique Structural Requirements: Exo

Environmental Control Requirements: Louver

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: SEP

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: 3-axis, thrusters

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S-band

Antennas: Parabolic dish

Computers: ______ Commands: ______

Type of Electrical Power System: From SEP

Average Power: ______ Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE   Code NU2-34

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

WEIGHTS

Code NU2-34

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			18	(40)
Environmental Control			9	(20)
Guidance, Navigation, Stabilization			0	(0)
Propulsion			50	(110)
Propellant	45	(98)		
Subsystem Dry	5	(12)		
Attitude Control (Mass Expulsion)			18	(40)
Propellant	14	(30)		
Subsystem Dry	5	(10)		
Telemetry, Tracking, Command			18	(40)
Electrical			27	(60)
Batteries				
Conversion				
Conditioning	27	(60)		
Distribution				
Mission Equipment			9	(20)
SEP			924	(2,038)
Stage	452	(992)		
Propellant	457	(1,008)		
Tanks	17	(38)		
Total Weight - Dry			557	(1,232)
Total Weight - Including Expendables			1,073	(2,368)
Adapter			56	(122)
Launch Weight			1,129	(2,490)

Comments: ____________________

PAYLOAD DATA SHEET

TITLE: Encke Slow Flyby

AGENCY: NASA/OSS

CODE: NU2-35

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine the nature and constituents of the nucleus and coma, and investigate formative mechanisms

Spacecraft Description: Mariner class;SEP

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, comet intercept

Launch Window: NA days

Initial Launch Date: 1979 yr   No. of Satellites in System:

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 14,463 m/sec (47,500 ft/sec)

Satellite Weight:* 1,433 kg (3,159 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft)   (length) 5.2 m (17.0 ft)   (vol) 54.4 m^3 (1,922.7 ft^3)

General Comments: * includes SEP

See Ref. 21.

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MISSION EQUIPMENT   Code NU2-35

Weight: 75 kg (165 lb) Power: ________ W

Type of Experiment(s): Study the composition and physical state (gas, solid) of typical comet

Purpose of Experiment(s): Detailed knowledge of comets, particularly the physical mechanism manifested largely in the coma and tail, will help to explain the fundamental physics and dynamics of the solar system

Type of Sensor(s): TV, spectrometers, radiometers, magnetometer, particle sensors, plasma analyzers, dust detectors

Unique Sensor Requirements and Technology Status: SEP

Environmental Requirements: Dust

Data Processing and Transmission Requirements: ________

Attitude Control and Pointing Accuracy Requirements: ________

Propulsion Requirements: 10 - 15 kW SEP

SUPPORTING SUBSYSTEMS — Code: NU2-35

Unique Structural Requirements: Rollout solar arrays

Environmental Control Requirements: Louvers

Guidance and Navigation Requirements: Sun sensor and star tracker

Propulsive Requirements: SEP

Type Propellant: ____ Thrust: ____

Orbit Adjust: ____ Total Impulse: ____ kg-sec (____ lb-sec)

Apogee Kick Motor: ____

Attitude Control: 3-axis, thrusters

Pointing Accuracy: ____ Pointing Direction: ____

Tracking, Telemetry and Command Requirements: S-band

Antennas: Parabolic dish

Computers: ____ Commands: ____

Type of Electrical Power System: Rollout solar cells

Average Power: ____ Peak Power: ____

Unique Interstage/Adapter Requirements: ____

SHUTTLE INTERFACE   Code NU2-35

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			123	(270)
Environmental Control			16	(35)
Guidance, Navigation, Stabilization			0	(0)
Propulsion (15 kW SEP)			979*	(2,159)*
Propellant	509	(1,123)		
Subsystem Dry	450	(992)		
Tanks	20	(44)		
Attitude Control (Mass Expulsion)			52	(115)
Propellant	36	(80)		
Subsystem Dry	16	(35)		
Telemetry, Tracking, Command			86	(190)
Electrical			102	(225)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			75	(165)
Total Weight - Dry			888	(1,956)
Total Weight - Including Expendables			1,433	(3,159)
Adapter			69	(151)
Launch Weight			1,502	(3,310)

Comments: * Weights from Ref. 21.

PAYLOAD DATA SHEET

TITLE: Encke Rendezvous

AGENCY: NASA/OSS

CODE: NU2-36

PROGRAM: Planetary Exploration

COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine physical state, composition, and dimensions of the Comet Encke nucleus; rate at which nucleus releases material, and the variation of the rate with solar distance; and composition of molecules and ions

Spacecraft Description: 15 kW SEP, Mariner class; deploys nucleus probe: effects rendezvous

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Planetary, 3 A. U. heliocentric, comet rendezvous

Launch Window: 20 days

Initial Launch Date: 1984 yr   No. of Satellites in System: 2

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 14,463 m/sec (47,500 ft/sec)

Satellite Weight:* 1,449 kg (3,193 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 6.1 m (20.0 ft) (vol) 44.5 m^3 (1,570.0 ft^3)

General Comments: Opportunity to rendezvous with Comet Encke in 1984

* Includes SEP

See Ref. 21

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MISSION EQUIPMENT Code NU2-36

Weight: 130 kg (286 lb) Power: 100 W

Type of Experiment(s): Study the composition and physical state (gas, solid) ot typical comet

Purpose of Experiment(s): Scientific data may lead to an interpretation of the origin of comets and help explain the origin of the solar system

Type of Sensor(s): Mass and UV spectrometers, TV imager, dust particle sensors, IR radiometer, photometer, radar receiver, plasma wave detector, magnetometer

Unique Sensor Requirements and Technology Status: Comet rendezvous and SEP

Environmental Requirements: Solar distances below 0.65 A.U.

Data Processing and Transmission Requirements: 4 kbps, 10^9 bits storage

Attitude Control and Pointing Accuracy Requirements: 1 arc min optical sensing accuracy for rendezvous guidance

Propulsion Requirements: 15 kW SEP; rendezvous and stationkeeping

SUPPORTING SUBSYSTEMS

Code NU2-36

Unique Structural Requirements: Exo type; may use rollout solar arrays

Environmental Control Requirements: Passive subsystem

Guidance and Navigation Requirements: Star tracker and optical target tracking

Propulsive Requirements: 1) SEP for trans-comet, and 2) chemical rocket for maneuvers

Type Propellant: 1) Mercury 2) N_2H_4

Thrust: 1) 15 kW with I_{sp} = 3,000 sec 2) 4.4 N (1 lb) thrusters

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: None

Attitude Control: 3-axis

Pointing Accuracy: 1 arc min

Pointing Direction: Comet Encke

Tracking, Telemetry and Command Requirements: S-band

Antennas: 2.4-m (8.0-ft) gimballed parabolic, S-band

Computers: ______ Commands: ______

Type of Electrical Power System: Solar arrays and battery

Average Power: 15 kW

Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NU2-36

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			140*	(308)*
Environmental Control			10*	(22)*
Guidance, Navigation, Stabilization			40*	(88)*
Propulsion (15 kW SEP)			979	(2,159)
Propellant	509	(1,123)		
Subsystem Dry	450**	(992)		
Tanks	20	(44)		
Attitude Control (Mass Expulsion)			40*	(88)*
Propellant	30	(66)		
Subsystem Dry	10	(22)		
Telemetry, Tracking, Command			90*	(198)*
Electrical			20*	(44)*
Batteries				
Conversion				
Conditioning	20	(44)		
Distribution				
Mission Equipment			130*	(286)*
Total Weight - Dry			910	(2,004)
Total Weight - Including Expendables			1,449	(3,193)
Adapter			50	(110)
Launch Weight			1,499	(3,303)

Comments: Weights based on reference document.

* Spacecraft + probe = 470 kg (1,035 lb)

** Solar array = 250 kg (552 lb) plus thruster array = 125 kg (275 lb) plus power conditioning = 75 kg (165 lb) totals 450 kg (992 lb)

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PAYLOAD DATA SHEET

TITLE: Asteroid Rendezvous AGENCY: NASA/OSS

CODE: NU2-37

PROGRAM: Planetary Exploration COGNIZANT ENGINEER: D. Herman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Determine properties of asteroid (e.g., Eros) body and its environment

Spacecraft Description: SEP system

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 3 A.U. heliocentric, rendezvous and landing on an asteroid

Launch Window: 180 days

Initial Launch Date: 1989 yr No. of Satellites in System: 2

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: NA %

Characteristic Velocity: 11,125 m/sec (36,500 ft/sec)

Satellite Weight: * 1,652 kg (3,640 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 6.1 m (20.0 ft) (vol) 44.5 m^3 (1,570.0 ft^3)

General Comments: * includes SEP and retro-propulsion

See Ref. 22

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MISSION EQUIPMENT Code NU2-37

Weight: 227 kg (500 lb) Power: 100 W

Type of Experiment(s): Measure size, shape, and mass; surface characteristics; nature of rotational motion; composition and structure

Purpose of Experiment(s): To determine whether asteroids represent an intermediate stage in the formation of a planet, or are fragments of an old planet

Type of Sensor(s): Imager, IR radiometer, magnetometer, plasma, field sensor, spectrometer, particle sensor, seismometer, penetrometer

Unique Sensor Requirements and Technology Status: SEP

Environmental Requirements: Micrometeoroids

Data Processing and Transmission Requirements: 10^7 bits/day, 10^8 bits storage

Attitude Control and Pointing Accuracy Requirements: ± 1 deg

Propulsion Requirements: 10 kW SEP

SUPPORTING SUBSYSTEMS Code NU 2-37

Unique Structural Requirements: Exo type; rollout solar arrays

Environmental Control Requirements: Passive (louver)

Guidance and Navigation Requirements: Elaborate command, decoding, and programming subsystem for approach, rendezvous, and docking

Propulsive Requirements: SEP

Type Propellant: Mercury, N_2O_4/MMH Thrust: 4 - 114 N (25 lb) thrusters 6-mercury ion thrusters

Orbit Adjust: SEP and Chemical Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: No

Attitude Control: 3-axis and thrusters (GN_2)

Pointing Accuracy: $\pm$ 1 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: S-band

Antennas: Low/med/high-gain, S-band, 2.7 m (9.0 ft) parabolic

Computers: Nav/Guid/Data Process. Commands:

Type of Electrical Power System: Rollout solar array 62 m^2 (670 ft^2) and battery

Average Power: 220 W Peak Power: 562 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NU2-37

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: None

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

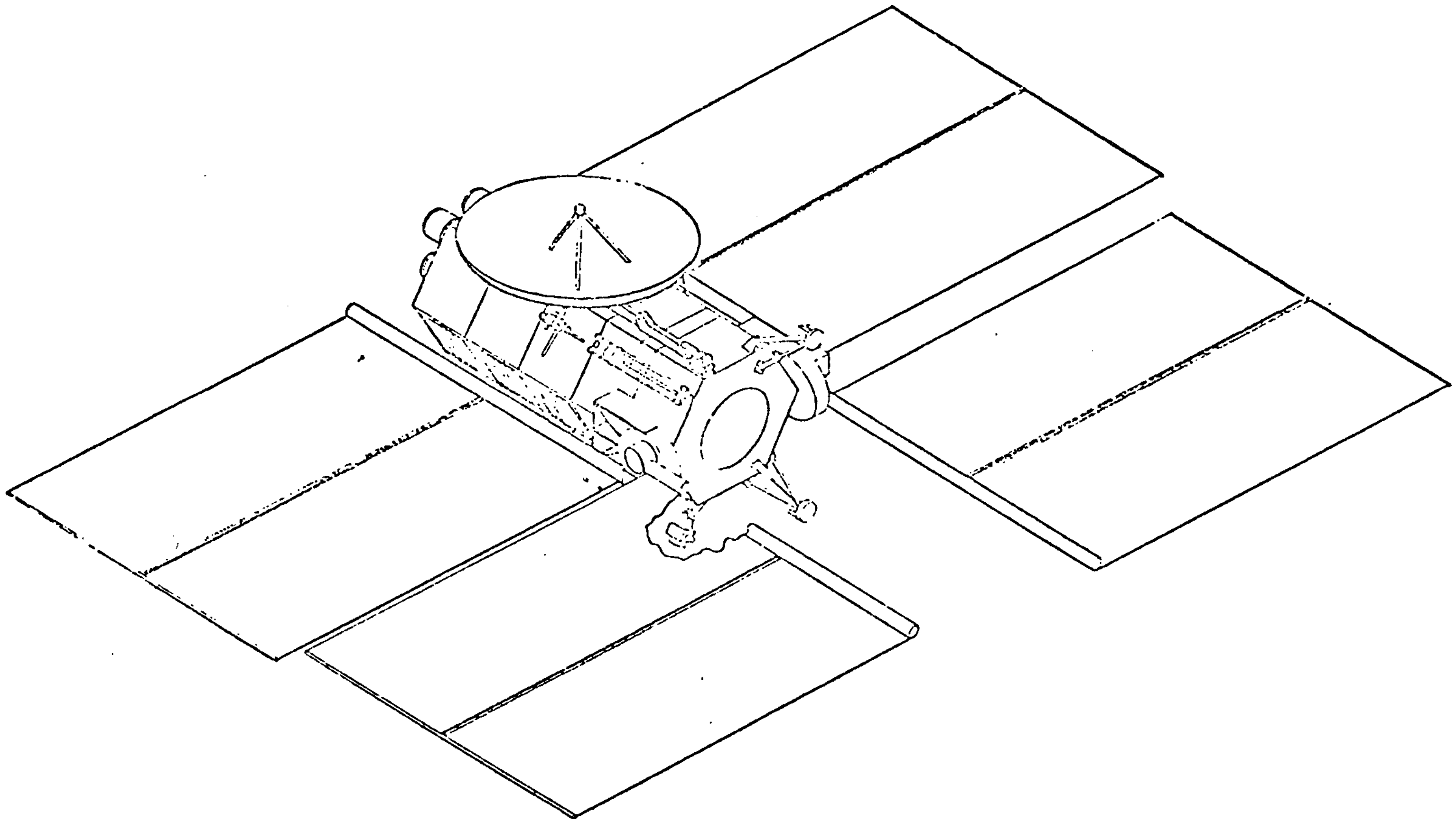
Requirement for Retrieval: Yes ____ No X Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			136	(300)
Environmental Control			32	(70)
Guidance, Navigation, Stabilization			27	(60)
Propulsion (Chem Retro)			100	(220)
Propellant	68	(150)		
Subsystem Dry	32	(70)		
Propulsion (10.5 kW SEP)			885	(1,950)
Propellant	454	(1,000)		
Subsystem Dry	431	(950)		
Attitude Control (Mass Expulsion)			73	(160)
Propellant	50	(110)		
Subsystem Dry	23	(50)		
Telemetry, Tracking, Command			91	(200)
Electrical Dist.			45	(100)
Mission Equipment			36	(80)
Mission Module			227	(500)
Structure	57	(125)		
Equipment	82	(180)		
Sample Acquisition	88	(195)		
Total Weight - Dry			1,080	(2,380)
Total Weight - Including Expendables			1,652	(3,640)
Adapter			50	(110)
Launch Weight			1,702	(3,750)

Comments: Weights are proportioned from reference document to total 1,652 kg (3,640 lb)



Spacecraft Concept for Asteroid Rendezvous (Typical)

VII. Earth Observations,
Earth and Ocean Physics

PAYLOAD DATA SHEET

TITLE: Earth Observatory Satellite **AGENCY:** NASA/OA

CODE: NE2-38

PROGRAM: Earth Observations **COGNIZANT ENGINEER:** T. Hechler

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Design, develop, and operate a space observatory system to perform environmental quality, meteorological, oceanographic, and earth resources surveying by advanced remote sensing techniques

Spacecraft Description: Satellite is an R&D version of the Earth Observation Satellite.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 926 ± 93 (500 ± 50)/926 ± 93 (500 ± 50)/98°

Launch Window: Sun synchronous (9:00 AM or 3:00 PM orbit plane)**

Initial Launch Date: 1978 yr **No. of Satellites in System:** 2

System Expected Lifetime: * yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8,203 m/sec (26,913 ft/sec)

Satellite Weight: 1,100 kg (2,400 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 3.5 m (11.5 ft) (vol) 25.6 m^3 (903.2 ft^3)

General Comments: * Sensor R&D program **The specific orbit plane depends on mission equipment. Also, some of these payloads have a seasonal launch preference which depends on mission discipline; i.e., Agriculture, Forestry, and Water Resources types have a preference for spring and summer seasons, whereas Geological types have no preference.

MISSION EQUIPMENT Code NE2-38

Weight: 413 kg (910 lb) Power: 560 W

Type of Experiment(s): Develop techniques and applications for using space-acquired environmental data in meteorological and earth resource surveys

Purpose of Experiment(s): Develop advanced sensors for atmospheric sciences and earth resources surveying

Type of Sensor(s): Radiometer, spectrophotometer, thematic mapper, atmosphere sounder, pollution sensor

Unique Sensor Requirements and Technology Status: Upper atmospheric sounder and atmospheric pollution sensor are under development

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 31 Mbps

Attitude Control and Pointing Accuracy Requirements: 5 arc sec jitter and 10 arc min pointing control accuracy

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NE2-38

Unique Structural Requirements: Exo structure

Environmental Control Requirements: Active system requiring 300 W power to cool thematic sensor to 100°K

Guidance and Navigation Requirements: Stabilize spacecraft to mission equipment requirements

Propulsive Requirements: Attitude control

Type Propellant: N_2H_4 Thrust: 6 thrusters, 2.3 N (0.5 lb)

Orbit Adjust: No Total Impulse: 22,700 N-sec (5,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: Momentum dump; 3-axis, wheels, N_2H_4

Pointing Accuracy: 10 arc min Pointing Direction: Nadir

Tracking, Telemetry and Command Requirements: Use USB system. May require use of Tracking & Data Relay Satellite to provide real-time data.

Antennas: 2 to 3, 0.15 to 0.3 m (0.5 to 1 ft), S-band

Computers: None required Commands: 256-512 (32 bits) real time and stored

Type of Electrical Power System: "Oriented" solar array and battery

Average Power: 1,200 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-38

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace ____

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Retrieval will permit updating mission equipment.

WEIGHTS

Code NE2-38

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			181	(400)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			68	(150)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion)			27	(60)
Propellant	18	(40)		
Subsystem Dry	9	(20)		
Telemetry, Tracking, Command			82	(180)
Electrical, Solar Array*			318	(700)
Batteries Conversion Conditioning Distribution	318	(700)		
Mission Equipment			413	(910)
Total Weight - Dry			1,071	(2,360)
Total Weight - Including Expendables			1,089	(2,400)
Adapter 6%			54	(120)
Launch Weight			1,143	(2,520)

Comments: Weights based on expendable launch vehicle.

* 1,200 W

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PAYLOAD DATA SHEET

TITLE: Synchronous Earth Observatory Satellite (SEOS)　　AGENCY: NASA/OA

CODE: NE2-39

PROGRAM: Earth Observations　　COGNIZANT ENGINEER: T. Hechler

COGNIZANT SCIENTIST: ____________

MISSION OBJECTIVES: Research satellite to investigate and develop remote sensing techniques for measurement of the earth's surface and atmosphere from sync altitude; R&D platform for ERTS, METS, and earth physics experiments; determine dynamic phenomena that can be used in monitoring earth resources.

Spacecraft Description: Similar to ATS and SMS (Sync Meteorological Satellite)

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323) / 35,784 (19,323) / $0^\circ \pm 30^\circ$ (sync equatorial and inclined orbits)

Launch Window: ____________ days (nominal 95° W longitude)**

Initial Launch Date: 1980 yr　　No. of Satellites in System: 1 (experimental)

System Expected Lifetime: * yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: ____________ %

Characteristic Velocity: 12,096 m/sec (39,684 ft/sec)

Satellite Weight: 1,134 kg (2,500 lb)

Satellite Launch Dimensions: (diam) 2.4 m (8.0 ft)　(length) 3.7 m (12.0 ft)　(vol) 17.0 m^3 (603.2 ft^3)

General Comments: Satellite is a sensor development for synchronous orbit. When the sensors are developed, they will then be designed and tested as a system. The system concept is called the Synchronous ERS.

* R&D

** The specific orbit plane depends on mission discipline; i.e., Agriculture, Forestry, and Water Resources types have a preference for spring and summer seasons, whereas Geological types have no preference.

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MISSION EQUIPMENT Code NE2-39

Weight: 408 kg (900 lb) Power: 1,000 W

Type of Experiment(s): Earth resource, meteorological and earth physics types of sensors

Purpose of Experiment(s): To monitor heavy population, floods, forest fires, pollution, anomalous snow pack, and cloud cover

Type of Sensor(s): (1) Imaging spectrometers and thermal IR scanners; (2) microwave sensor; or (3) film camera (each sensor group on separate satellite)

Unique Sensor Requirements and Technology Status: Better sensors need to be developed. Long focal length lenses required in the case of camera systems. Develop 1 to 1 1/2-m diam mirrors.

Environmental Requirements: Radiation shielding of vulnerable components

Data Processing and Transmission Requirements: Data compression with sensor outputs of extreme bandwidth; data rate 30 Mbps

Attitude Control and Pointing Accuracy Requirements: 5 arc sec jitter. 6 arc min control

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NE2-39

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Passive

Guidance and Navigation Requirements:

Propulsive Requirements: Stationkeeping and attitude control

Type Propellant: N_2H_4 Thrust: 6 thrusters, 2.3 N (0.5 lb)

Orbit Adjust: Stationkeeping Total Impulse: 71,200 N-sec (16,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: Momentum dump; 3-axis, wheels, and N_2H_4

Pointing Accuracy: 6 arc min Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: Use USB system

Antennas: 2 to 4, 0.15 to 0.9 m (0.5 to 3 ft) diam, omni/earth coverage, S-band

Computers: Possible need for data compression Commands: 256-512 (32 bits) real time and stores

Type of Electrical Power System: "Oriented" solar array and battery

Average Power: 1,500 W Peak Power: 2,000 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-39

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Visits are desirable to replace camera film periodically. Color film and free-radical emulsions have very much higher acuity and information storage capability than the vidicon camera, but life of film is in the order of one year.

Code NE2-39

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			159	(350)
Environmental Control			9	(20)
Guidance, Navigation, Stabilization			30	(65)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion)			54	(120)
Propellant	36	(80)		
Subsystem Dry	18	(40)		
Telemetry, Tracking, Command			43	(95)
Electrical*			431	(950)
Batteries, Conversion, Conditioning } Solar array incl substrate	386	(850)		
Distribution	45	(100)		
Mission Equipment			408	(900)
Total Weight - Dry			1,098	(2,420)
Total Weight - Including Expendables			1,134	(2,500)
Adapter			45	(100)
Launch Weight			1,179	(2,600)

Comments: Total weight and total power requirement specified, remaining weights based on statistical analysis; all weights based on expendable launch vehicle.

* 1,500 W average, 2,000 W peak

1. Title: <u>Synchronous Earth Observatory Satellite</u>

2. Mission: To design, develop and operate an experimental R&D satellite for remote sensing of the Earth's surface and the lower regions of the atmosphere from synchronous orbital altitudes.

3. Objectives:

   A. The primary purpose of this mission would be not only to verify the capability and need for observing rapidly changing conditions in the vicinity of the Earth's surface, but also to include a capability to be responsive upon command to view in real time specific dynamic environmental and earth resources phenomena occurring in a designated geographic region. Specific phenomena, which would be monitored by this satellite include---

      a. Region of heavy local precipitation

      b. Flood situations

      c. Early detection of forest fires

      d. Changes in pollution of the lower atmosphere

      e. Anomalous snow packs

      f. Sea state

      g. Earthquakes

   B. If the satellite is placed in the proper geosynchronous orbit, in conjunction with other geosynchronous satellites such as ATS, SMS or GEOS, stereo coverage of specific areas or phenomena can be obtained over short time intervals.

4. Payload:

   A. Visible and thermal infrared scanners and radiometers

   B. Passive and active microwave scanners

   C. Imaging spectrometers

   D. Data collection system

5. Launch Vehicle: Not yet determined

6. Alternative Flight Objectives and Payload: The relative resolution imagery instrumentation proposed for this mission would be capable of providing continuous meteorological coverage of the U. S. Energy transfers in the atmosphere could be measured to a high degree of precision. Additional instruments specifically oriented towards the meteorological requirements could be added to the payload.

7. Technically Critical Factors:

   A. Development of suitable sensors

   B. This mission will probably require a Titan III-D/Centaur or equivalent capacity launch vehicle

   C. Substantial electric power source will be needed

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PAYLOAD DATA SHEET

TITLE: TIROS-O

AGENCY: NASA/OA

CODE: NE2-40

PROGRAM: Earth Observations

COGNIZANT ENGINEER: M. Garbacz

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Develop advanced sensors to determine atmospheric pressure and density, vertical temperature and wind profiles, and sea state, convection, and surface temperature

Spacecraft Description: Follow-on to TIROS-N (see attachment)

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 1,678 (906)/1,678 (906)/ 103^{o} (sun synchronous)

Launch Window: Sun sync (9:00 AM orbit plane)

Initial Launch Date: 1981 yr   No. of Satellites in System: 1

System Expected Lifetime: 2 yr *

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8,555 m/sec (28,069 ft/sec)

Satellite Weight: 626 kg (1,380 lb)

Satellite Launch Dimensions: (diam) 2.4 m (8.0 ft) (length) 3.7 (12.0 ft) (vol) 17.1 m^3 (603.2 ft^3)

General Comments: See Ref.

* Data based on TIROS-N reference document.

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MISSION EQUIPMENT Code NE2-40

Weight: 263 kg (580 lb) Power: 200 W

Type of Experiment(s): See Mission Objectives

Purpose of Experiment(s): Develop an advanced operational meteorological satellite for ESSA

Type of Sensor(s): High resolution radiometers, vertical temperature sounders, and data collection equipment for free-floating balloons and ocean buoys

Unique Sensor Requirements and Technology Status: Develop advanced vertical sounders and radiometric instrumentation

Environmental Requirements: Components selected and shielded to minimize radiation damage

Data Processing and Transmission Requirements: 2.7 Mbps

Attitude Control and Pointing Accuracy Requirements: ±0.15 deg altitude determination; jitter: 0.025 deg/sec roll and 0.038 deg/sec pitch and yaw

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NE2-40

Unique Structural Requirements: Endo

Environmental Control Requirements: Passive

Guidance and Navigation Requirements:

Propulsive Requirements: Orbit adjust

Type Propellant: Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: 3-axis, wheels, magnetic torquers

Pointing Accuracy: 0.15° Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: S-band (STADAN)

Antennas:

Computers: Commands:

Type of Electrical Power System: Solar array and batteries

Average Power: 250 W Peak Power: 275 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-40

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

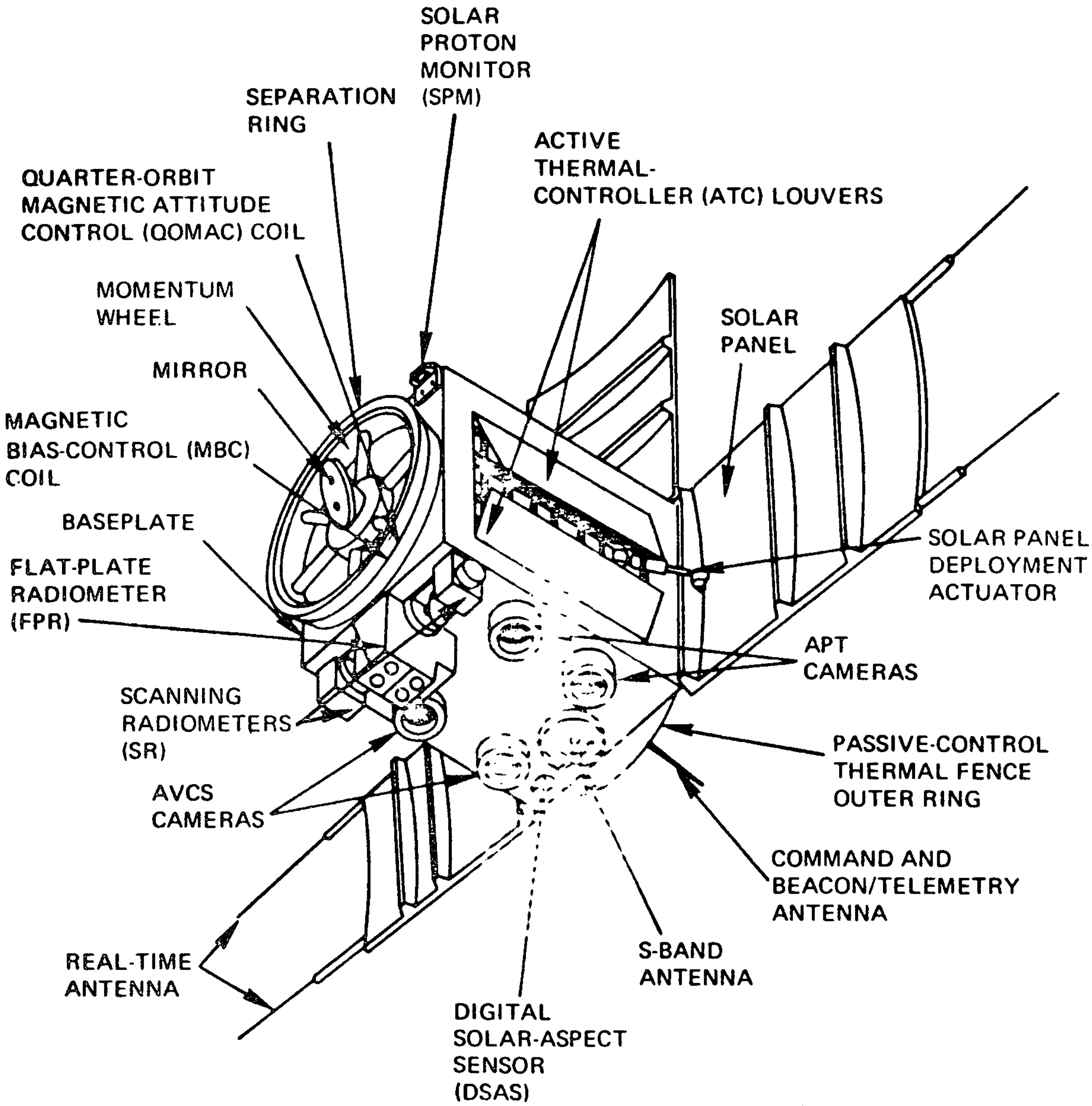
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

WEIGHTS

Code NE2-40

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			136	(300)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			27	(60)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			64	(140)
Propellant	41	(90)		
Subsystem Dry	23	(50)		
Telemetry, Tracking, Command			23	(50)
Electrical, 200 W			113	(250)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			263	(580)
Total Weight - Dry			585	(1, 290)
Total Weight - Including Expendables			626	(1, 380)
Adapter			45	(100)
Launch Weight			671	(1, 480)

Comments: __________



TIROS-M Spacecraft Configuration

PAYLOAD DATA SHEET

TITLE: Synchronous Meteorological Satellite

AGENCY: NASA-OA

CODE: NE2-41

PROGRAM: Earth Observations

COGNIZANT ENGINEER: M. Garbacz

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Develop a prototype operational geostationary meteorological satellite based on proven technology (derived from SEOS) for NOAA

Spacecraft Description: Prototype operational satellite

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323)/35,784 (19,323)/$0^\circ \pm 3^\circ$

Launch Window: ______ days (nominal 95° W longitude)*

Initial Launch Date: 1973 yr   No. of Satellites in System: 2

System Expected Lifetime: 4 yr

Satellite Mean Mission Duration: 4 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,684 ft/sec)

Satellite Weight: 243 kg (535 lb)

Satellite Launch Dimensions: (diam) 1.8 m (6.0 ft) (length) 1.8 m (6.0 ft) (vol) 4.8 m^3 (169.6 ft^3)

General Comments: Systems demonstration program

See Ref. 24 *

*Some of these payloads have a seasonal launch preference which depends on mission discipline; i.e., Agriculture, Forestry, and Water Resources types have a preference for spring and summer seasons, whereas Geological types have no preference.

MISSION EQUIPMENT Code NE2-41

Weight: 73 kg (160 lb) Power: 35 W

Type of Experiment(s): Provide near-continuous observation of cloud cover, and collect and relay data

Purpose of Experiment(s): Develop advanced operational system for NOAA

Type of Sensor(s): Visible and infrared spin scan radiometer (multi-channel) space environment monitor, and data collection and relay components

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 28 Mbps

Attitude Control and Pointing Accuracy Requirements: Spin-axis determination to 0.1 deg, precession control resolution to 5 arc secs

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NE2-41

Unique Structural Requirements: Endo

Environmental Control Requirements: Passive (no louvers)

Guidance and Navigation Requirements:

Propulsive Requirements: Attitude control and stationkeeping or change

Type Propellant: N_2H_4 Thrust: 4- 23 N (5 lb) thrusters, 2- 2.3N (0.5 lb) thrusters, redundant

Orbit Adjust: Total Impulse: 124,600 N-sec (28,000 lb-sec)

Apogee Kick Motor:

Attitude Control: Dual spin, N_2H_4 thrusters; 50-110 rpm

Pointing Accuracy: 0.1 deg Pointing Direction: Earth scan

Tracking, Telemetry and Command Requirements: VHF, UHF, and S-band

Antennas: UHF and S-band: mounted on cylinder 1.3 m (4.2 ft) diam X 0.5 m (1.7 ft) length (see attachment); 128 yagi S-band elements and 16 massed dipole UHF elements; VHF: omni antenna

Computers: Commands:

Type of Electrical Power System: Body-mounted solar array and batteries

Average Power: 150 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-41

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical ______

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: ______

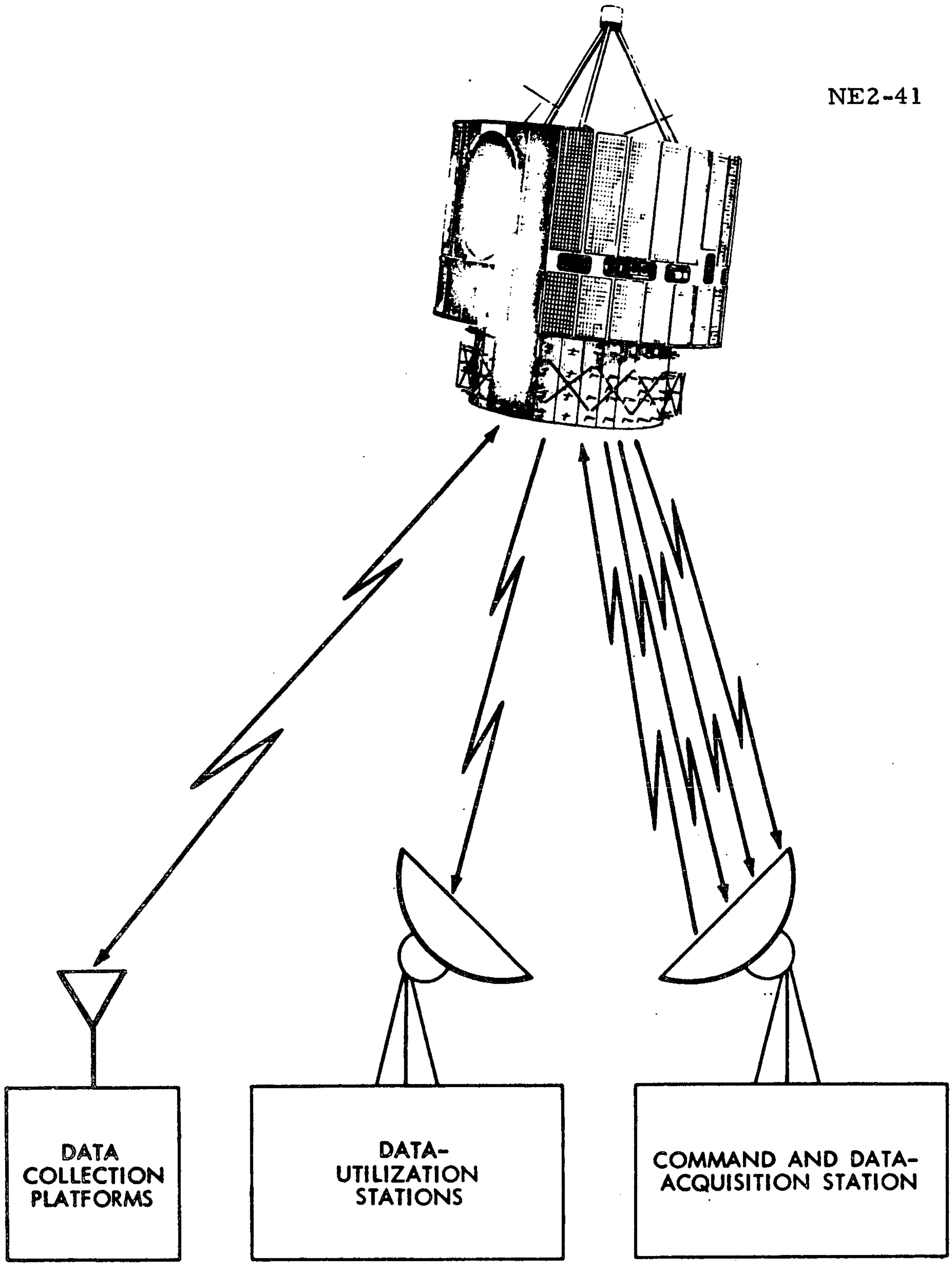
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______

 Code NE2-41

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			57	(125)
Environmental Control			9	(20)
Guidance, Navigation, Stabilization			5	(10)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			27	(60)
Propellant	16	(35)		
Subsystem Dry	11	(25)		
Telemetry, Tracking, Command			18	(40)
Electrical, 150 W			54	(120)
Batteries, Conversion, Conditioning } unoriented solar cells	45	(100)		
Distribution	9	(20)		
Mission Equipment			73	(160)
Total Weight - Dry			227	(500)
Total Weight - Including Expendables			243	(535)
Adapter			25	(55)
Launch Weight			268	(590)

Comments: ______________________

NE2-41



The SMS System

PAYLOAD DATA SHEET

TITLE: Earth Resources Satellite **AGENCY:** NASA/OA

CODE: NE2-42

PROGRAM: Earth Observations **COGNIZANT ENGINEER:** T. Hechler

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Design, develop, and operate a space observatory system to obtain data for environmental control and earth resources management, for use by NOAA

Spacecraft Description: Satellite is a first generation operational prototype.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 926 ± 93 (500 ± 50)/ 926 ± 93 (500 ± 50)/98° (sun synchronous)

Launch Window: Sun sync (noon or 3:00 PM orbit plane)*

Initial Launch Date: 1979 **yr** **No. of Satellites in System:** 4

System Expected Lifetime: 2 **yr**

Satellite Mean Mission Duration: 2 **yr**

Satellite Desired Availability: ____ **%**

Characteristic Velocity: 8,203 **m/sec** (26,913 **ft/sec)**

Satellite Weight: 817 **kg** (1,800 **lb)**

Satellite Launch Dimensions: **(diam)** 3.0 m (10.0 ft) **(length)** 3.5 m (11.5 ft) **(vol)** 25.6 m^3 (903.2 ft^3)

General Comments: System demonstration program

* The specific orbit plane depends on mission equipment. Also, some of these payloads have a seasonal launch preference which depends on mission discipline; i.e., Agriculture, Forestry, and Water Resources types have a preference for spring and summer seasons, whereas Geological types have no preference.

MISSION EQUIPMENT Code NE2-42

Weight: 141 kg (310 lb) Power: 560 W

Type of Experiment(s): Develop a system, techniques, and applications for using space-acquired resource data

Purpose of Experiment(s): Develop a system with advanced sensors for atmospheric sciences and earth resources surveying

Type of Sensor(s): Radiometer, spectrophotometer, thematic mapper, atmospheric sounder, atmospheric pollution sensor

Unique Sensor Requirements and Technology Status: Sounder and pollution sensor

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 31 Mbps

Attitude Control and Pointing Accuracy Requirements: 5 arc sec jitter for thematic mapper

Propulsion Requirements: Sun synchronous

SUPPORTING SUBSYSTEMS Code NE2-42

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Active system requiring 300 W power to cool thematic sensor to $100^{o}K$

Guidance and Navigation Requirements: Stabilize spacecraft to mission equipment requirements

Propulsive Requirements: Attitude control

Type Propellant: N_2H_4 **Thrust:** 6 thrusters - 2.3 N (0.5 lb)

Orbit Adjust: No **Total Impulse:** 22,700 N.sec (5,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: Momentum dump; 3-axis, wheels N_2H_4

Pointing Accuracy: 10 arc min **Pointing Direction:** Earth

Tracking, Telemetry and Command Requirements: S-band (USB system)

Antennas: 2 to 3, < 0.6 m (2 ft), omni/low gain

Computers: **Commands:** 128-512 (32 bits) real time and stored

Type of Electrical Power System: "Oriented" solar array and battery

Average Power: 1,200 W **Peak Power:**

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE   Code NE2-42

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1 each 2 years

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

.pected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

WEIGHTS

Code NE2-42

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			181	(400)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			68	(150)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			27	(60)
Propellant	18	(40)		
Subsystem Dry	9	(20)		
Telemetry, Tracking, Command			82	(180)
Electrical, 1,200 W			318	(700)
Batteries / Conversion / Conditioning } solar cells oriented	318	(700)		
Distribution				
Mission Equipment			141	(310)
Total Weight - Dry			799	(1,760)
Total Weight - Including Expendables			817	(1,800)
Adapter 5%			41	(90)
Launch Weight			858	(1,890)

Comments: Based on expendable launch vehicle

PAYLOAD DATA SHEET

TITLE: Synchronous Earth Observatory Satellite - Prototype

AGENCY: NASA/OA

CODE: NE2-43

PROGRAM: Earth Observations

COGNIZANT ENGINEER: B. Schard

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Design, develop, and operate a satellite system for remote sensing of the earth's surface and the lower regions of the atmosphere from synchronous orbital altitude

Spacecraft Description: Similar to Synchronous Meteorological Satellite

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323)/ 35,784 (19,323)/$0^{o} \pm 3^{o}$ (synchronous equatorial)

Launch Window: ______ days (nominal 95^{o} W longitude)

Initial Launch Date: 1990 yr   No. of Satellites in System: 2

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 2 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,685 ft/sec)

Satellite Weight: 1,197 kg (2,640 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 3.7 m (12.0 ft) (vol) 26.7 m^3 (942.4 ft^3)

General Comments:

MISSION EQUIPMENT Code NE2-43

Weight: 635 kg (1,400 lb) Power: 250 W

Type of Experiment(s): System demonstration of a system to monitor local pollution, geothermal sources, water resources, and agricultural inventory

Purpose of Experiment(s): Develop a system to monitor rapidly changing conditions near the earth's surface and to be responsive upon command to view in real time dynamic environmental and earth resource phenomena

Type of Sensor(s): IR and visible scanners and radiometers, passive and active microwave scanners, or imagery spectrometers (sensors on separate spacecraft)

Unique Sensor Requirements and Technology Status: Develop sensors for earth resource monitoring from synchronous altitude

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 30 Mbps

Attitude Control and Pointing Accuracy Requirements: 5 arc sec jitter, 6 arc min pointing control

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NE2-43

Unique Structural Requirements: Exo type structure

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Stabilize spacecraft to mission equipment requirements

Propulsive Requirements: Stationkeeping and momentum dump

Type Propellant: N_2H_4 Thrust: 6 thrusters - 2.3 N (0.5 lb)

Orbit Adjust: Stationkeeping Total Impulse: 71,200 N-sec (16,000 lb-sec)

Apogee Kick Motor: None

Attitude Control: Momentum dump; 3-axis, wheels

Pointing Accuracy: 6 arc min Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: Use USB system

Antennas: 2 to 4, 0.9 m (3 ft) diam, omni/earth coverage

Computers: Possible need for data compression Commands:

Type of Electrical Power System: Solar array and battery

Average Power: 400 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-43

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout ____

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Satellite can be launched with other payloads.

WEIGHTS

Code NE2-43

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			188	(415)
Environmental Control			9	(20)
Guidance, Navigation, Stabilization			68	(150)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			54	(120)
Propellant	36	(80)		
Subsystem Dry	18	(40)		
Telemetry, Tracking, Command			82	(180)
Electrical, 400 W			161	(355)
Batteries, Conversion, Conditioning } solar array incl substrate	136	(300)		
Distribution	25	(55)		
Mission Equipment			635	(1, 400)
Total Weight - Dry			1, 161	(2, 560)
Total Weight - Including Expendables			1, 197	(2, 640)
Adapter			60	(132)
Launch Weight			1, 257	(2, 772)

Comments: Total weight and total power specified; remaining weights based on statistical analysis. All weights based on expendable launch vehicle.

PAYLOAD DATA SHEET

TITLE: Earth Observation Laboratory-Sortie   AGENCY: NASA/OA

CODE: NE2-44

PROGRAM: Earth Observations   COGNIZANT ENGINEER: T. Hechler

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Define earth's geometry, surface characteristics, and dynamic body properties; understand physics of atmosphere, predict weather, and the establishment of a basis for weather modification; and management of earth's resources

Spacecraft Description: Manned orbital facility that uses man in the orbital survey

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: $185 {}^{+315}_{-0}$ $(100 {}^{+170}_{-0})$/ $185 {}^{+315}_{-0}$ $(100 {}^{+170}_{-0})$/$90^{\circ} {}^{+20^{\circ}}_{-35^{\circ}}$

Launch Window: Sun sync (9:00 AM, noon, or 3:00 PM orbit plane)*

Initial Launch Date: 1980 yr   No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: 7,797 m/sec (25,581 ft/sec)

Satellite Weight: 6,107 kg (13,462 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 5.8 m (19.0 ft) (vol) 82.8 m^3 (2,924.8 ft^3)

General Comments: For a representative earth observation experiment, the land use mapping mission was selected. Other candidate missions are meteorology and atmospheric science, air and water pollution, resource recognition and identification, natural disaster assessment, and ocean resources.

See Ref. 9 and 10, Payload No. E 1510; and Ref. 25   * See General Comments, NE2-38 et seq

MISSION EQUIPMENT   Code NE2-44

Weight: 2,218 kg (4,889 lb)   Power: 4.9 kW

Type of Experiment(s): Initial flight to be limited to western hemisphere observations and measurements.

Purpose of Experiment(s): Collect cartographic data for use in increasing the coverage of world-wide thematic and land use maps

Type of Sensor(s): Metric camera, multispectral camera, multispectral scanner, microwave scanner, microwave radar, multispectral radiometer, scatterometer

Unique Sensor Requirements and Technology Status:

Environmental Requirements: Minimum thruster operation during viewing to reduce contamination

Data Processing and Transmission Requirements: 50 Mbps and film

Attitude Control and Pointing Accuracy Requirements: ± 0.5 deg pointing and 0.05 deg/sec stability

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NE2-44

Unique Structural Requirements: None. Endo for module and exo for mission equipment.

Environmental Control Requirements: Manned system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: ____ Thrust: ____

Orbit Adjust: ____ Total Impulse: ____ kg-sec (____ lb-sec)

Apogee Kick Motor: ____

Attitude Control: Orbiter

Pointing Accuracy: ± 0.5 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: S-band, 50 Mbps

Antennas: ____

Computers: ____ Commands: ____

Type of Electrical Power System: Orbiter

Average Power: 4.9 kW Peak Power: ____

Unique Interstage/Adapter Requirements: ____

SHUTTLE INTERFACE | Code NE2-44

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: ____

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: On-orbit maintenance and ground refurbishment

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Sortie missions possible only with Shuttle.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			2,294	(5,058)
Structures	1,687	(3,720)		
Env Protection	516	(1,138)		
Docking	91	(200)		
Environmental Control			821	(1,810)
Atmos & Therm Control	644	(1,420)		
Life Supp & Interiors	177	(390)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry			463	(1,020)
Data Management	195	(430)		
Communications	111	(245)		
Displays & Control	157	(345)		
Electrical			311	(685)
Conversion, Conditioning, Distribution *	123	(270)		
Checkout	9	(20)		
Wiring	179	(395)		
Mission Equipment			2,218	(4,889)
Exp Apparatus	1,172	(2,583)		
Exp Support	259	(570)		
Gen Purpose Support	483	(1,065)		
Exp Integration	266	(587)		
Expendables	38	(84)		
Total Weight - Dry			6,064	(13,378)
Total Weight - Including Expendables			6,107	(13,462)
Crew Equipment, 61 kg (135 lb), and Residuals, 455 kg (1,000 lb)			515	(1,135)
Launch Weight			6,622	(14,597)

Comments:

* The prime power source is assumed to be supplied by the Orbiter.

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PAYLOAD DATA SHEET

TITLE: GEOPAUSE

AGENCY: NASA/OA

CODE: NE2-45

PROGRAM: Earth Observations

COGNIZANT ENGINEER: B. Milwitsky

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Make precision measurements of the earth's land and sea areas to determine mass distribution, variation of gravity, and altitude.

Spacecraft Description: 227-454 kg (500-1,000 lb) class satellite with multiple payload capability (several concepts under consideration*)

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270)/500 (270)/90°

Launch Window: None days

Initial Launch Date: 1979 yr

No. of Satellites in System: 1

System Expected Lifetime: 12 yr (desired)

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 323 kg (710 lb)

Satellite Launch Dimensions: (diam) 1.5 m (5.0 ft) (length) 2.7 m (9.0 ft) (vol) 5.0 m^3 (176.7 ft^3)

General Comments: * (1) two satellites 100 to 200 km (54 to 108 n mi) apart, (2) two satellites which are at 4.6 radii and at low altitude, and (3) advanced altimeter satellite

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MISSION EQUIPMENT — Code NE2-45

Weight: 57 kg (125 lb) Power: ______ W

Type of Experiment(s): Precision ranging of 10 cm geoid accuracy

Purpose of Experiment(s): Determine mean sea level and deviations of the ocean surface on a global scale on a day-by-day basis

Type of Sensor(s): Altimeter

Unique Sensor Requirements and Technology Status: Altimeter to measure earth surface altitude to better than 50 cm (10 cm goal) and ground-based laser satellite tracking stations with ranging accuracies of 15 cm

Environmental Requirements: Natural

Data Processing and Transmission Requirements: 10 to 20 kbps

Attitude Control and Pointing Accuracy Requirements: ± 3 deg satellite pointing and ± 30 sec attitude determination

Propulsion Requirements: ______

SUPPORTING SUBSYSTEMS Code NE2-45

Unique Structural Requirements: Endo and deployable boom

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: Attitude determination accuracy, 30 arc sec, requires star scanner or tracker

Propulsive Requirements: Possible for drag-free and orbit circularization

Type Propellant: Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor: None

Attitude Control: Gravity gradient with pitch wheel

Pointing Accuracy: ± 3 deg Pointing Direction: Nadir

Tracking, Telemetry and Command Requirements: USB; store 2 orbits of data

Antennas: Omni-directional and high gain

Computers: Commands:

Type of Electrical Power System: Solar array and battery

Average Power: 125 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NE2-45

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 1

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No ___ Desirable X

Expected Maintenance Philosophy: ___

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: On-orbit checkout and extend satellite life by retrieval/refurbishment

WEIGHTS

Code NE2-45

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			91	(200)
Environmental Control			7	(15)
Guidance, Navigation, Stabilization			45	(100)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			32	(70)
Electrical, Pyrotechnics Batteries Conversion Conditioning Distribution			91	(200)
Mission Equipment			57	(125)
Total Weight			323	(710)
Adapter			18	(40)
Launch Weight			341	(750)

Comments: ______

1. Title: <u>Earth Physics Satellites</u> (EPS-A, B, C)

2. Mission: Design, develop, launch, and operate a series of R & D drag free satellites in near circular polar orbits about the Earth to support accurate measurements of the spatial and time variations of the shape and figure of the ocean surface and the solid Earth, the gravity and magnetic fields, and other geophysical parameters.

3. Objectives:

   To support the acquisition of sufficient precision tracking data for the determination of the variations of the gravity field to 250 km half-wavelength required to gain an understanding of density variations in the Earth's crust and for detecting mass displacements.

   To provide space platforms for altimeters which will provide the high accuracy data required for the determination of mean sea level and deviations of the ocean surface from mean sea level which will enable physical oceanographers to develop a model to describe oceanic circulation on a global scale on a day-by-day basis.

   To provide near Earth space platforms for very sensitive triaxial magnetometers with precise attitude control for measuring variations in the short wavelength components of the terrestrial magnetic field so that geologists may improve their understanding of the crustal inhomogeneities.

4. Payload:

   Laser Retroreflectors
   Passive C-Band Radar Reflector
   C-Band Radar Transponder
   S-Band Radar Transponder
   Radar Altimeter
   Vector Magnetometers
   Low-g Accelerometer
   Satellite-to-Satellite Tracking Transponder

5. Launch Vehicle: Delta or Advanced Scout

6. Alternative Flight Objectives and Payloads: None

7. Technically Critical Factors:

   Fabrication and flight test of spacecraft drag compensation system.
   Development, flight test, calibration, and performance evaluation of satellite radar altimeters having an accuracy of better than 50 cm.
   Availability of ground base laser satellite tracking stations with ranging accuracies of 15 cm.

1. Title: <u>Geodetic Earth Orbiting Satellite (GEOS)-C</u>

2. Mission: To design, develop, launch and operate an experimental R&D satellite for geodetic observations from space.

3. Objectives:

   To achieve an orbit with an inclination near 20° and obtain gravity gradient stabilization so that low inclination observation data can be acquired.
   To support the acquisition of sufficient precision spacecraft position data to be applied to the completion of the gravimetric objective of the National Geodetic Satellite Program (NGSP).
   To perform an in-orbit satellite altimeter experiment to determine its suitability for improving the description of the mean sea level and its capability for measuring small scale variations in this level (e.g., tides, geological effects on the ocean surface).
   To ascertain the feasibility, by means of a GEOS-C/ATS-F DRS tracking experiment, of satellite-to-satellite tracking for measuring short wavelength gravity anomalies and to determine the precision of the orbit determination technique.

4. Payload:

   Optical Beacons
   C-Band Transponders
   Radar Altimeter
   Laser Retroreflectors
   Doppler Beacons
   S-Band Transponders
   Passive Radar Reflectors
   Payload Weight:

5. Launch Vehicle:

6. Alternative Flight Objectives and Payload: None.

7. Technically Critical Factors:

VIII. Communication
and Navigation

PAYLOAD DATA SHEET

TITLE: Applications Technology Satellite   AGENCY: NASA/OA

CODE: NC2-46

PROGRAM: Communications & Navigation   COGNIZANT ENGINEER: S. Fordyce

COGNIZANT SCIENTIST: ______

MISSION OBJECTIVES: Develop and generate earth to geo-stationary orbit communication needs; advance general application technology (meteorology, earth observations, etc.); and develop satellite systems and spacecraft technology for space navigation and traffic control needs

Spacecraft Description: Investigate and flight test technology common to a number of satellite applications (similar to ATS F&G); R&D

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323) / 35,784 (19,323) / $0^{o} \pm 3^{o}$

Launch Window: ______ days

Initial Launch Date: 1973 yr   No. of Satellites in System: 2

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 3 yr

Satellite Desired Availability: 50 %

Characteristic Velocity: 12,096 m/sec (39,685 ft/sec)

Satellite Weight: 1,361 kg (3,000 lb)

Satellite Launch Dimensions: (diam) 2.7 m (9.0 ft) (length) 7.6 m 25.0 ft) (vol) 45.0 m^3 (1,590.4 ft^3)

General Comments: Major mission equipment development program; i.e., solar and antenna structures, controls, etc.; each P/L is different; R&D program; does not go operational.

MISSION EQUIPMENT

Code NC2-46

Weight: 221 kg (488 lb) Power: 1 kW nominal; 6-10 kW and up to 20 kW for later program

Type of Experiment(s): 12 GHz (1 kW) transmitter with multi-beam (15 - 20) high gain (1/4 deg nominal beamwidth) antennas

Purpose of Experiment(s): Establish feasibility of spaceborne high-power transmitters and contoured multi-beam antenna for future information system satellite

Type of Sensor(s): Communications - antenna/transmitter; contoured multi-beam antenna, 1/4 deg beamwidth

Unique Sensor Requirements and Technology Status: High-power transmitter (2 kW) not now available; high gain multi-beam antenna not now available

Environmental Requirements: Natural

Data Processing and Transmission Requirements: Standard

Attitude Control and Pointing Accuracy Requirements: Antenna directional positioning with 0.03 deg accuracy

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NC2-46

Unique Structural Requirements: Exo type, light weight solar array

Environmental Control Requirements: Passive system; active system for batteries (heat pipe and louvers suggested by NASA)

Guidance and Navigation Requirements:

Propulsive Requirements: E - W and N - S stationkeeping; attitude control

Type Propellant: N_2H_4/ ion engines Thrust:

Orbit Adjust: Stationkpg Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor:

Attitude Control: 3-axis, wheels

Pointing Accuracy: 0.03 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: Standard Stadan requirement

Antennas: Omni/earth coverage, S-band

Computers: Commands:

Type of Electrical Power System: "Oriented" solar array and battery

Average Power: 1 kW end of life Peak Power:

Unique Interstage/Adapter Requirements:

C-4

SHUTTLE INTERFACE Code NC2-46

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ______

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: ______

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain X Operate ______

Stay Time Required: 12-48 hr

Requirement for Retrieval: Yes ______ No ______ Desirable X

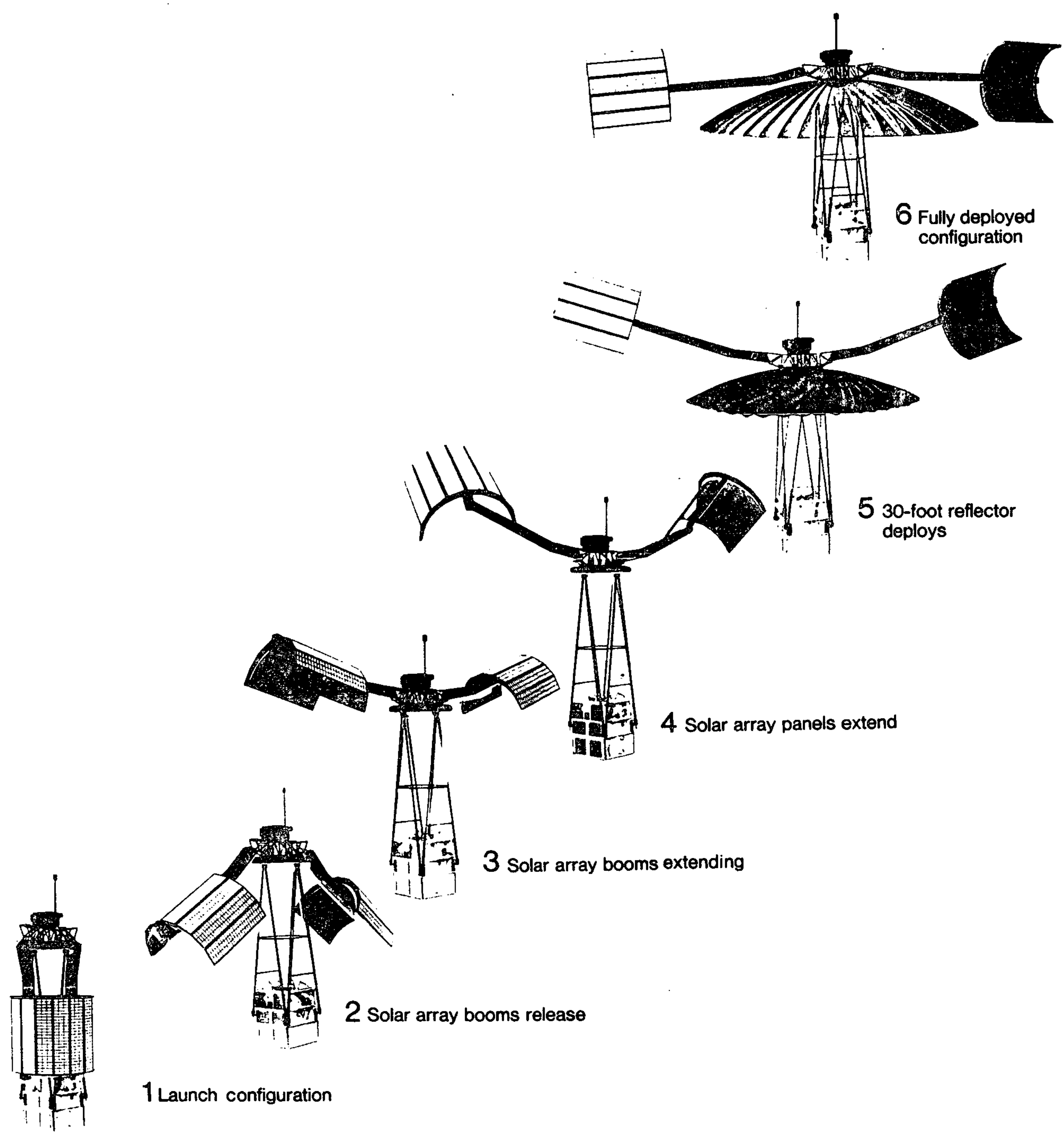
Expected Maintenance Philosophy: ______

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______

Code NC2-46

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			202	(445)
Environmental Control			50	(110)
Guidance, Navigation, Stabilization			136	(300)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			94	(207)
Propellant	68	(150)		
Subsystem Dry	26	(57)		
Telemetry, Tracking, Command			91	(200)
Electrical			567	(1,250)
Batteries / Conversion / Conditioning	522	(1,150)		
Distribution	45	(100)		
Mission Equipment			221	(488)
Total Weight - Dry			1,293	(2,850)
Total Weight - Including Expendables			1,361	(3,000)
Adapter			68	(150)
Launch Weight			1,429	(3,150)

Comments: ______________________________



ATS F&C Spacecraft Deployment

PAYLOAD DATA SHEET

TITLE: Small Applications Technology Satellite - Synchronous

AGENCY: NASA/OA

CODE: NC2-47

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: D. Silverman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Design, develop, launch, and operate a series of small R&D satellites for the experimental application of research and technology developments in spacecraft and sensor subsystems

Spacecraft Description: Provide low-cost, quick-reaction capabilities for one or two experiments per spacecraft

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323)/ 35,784 (19,323) $0^{o} \pm 3^{o}$

Launch Window: ______ days

Initial Launch Date: 1976 yr   No. of Satellites in System: 1

System Expected Lifetime: 1 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,685 ft/sec)

Satellite Weight: 137 kg (300 lb)

Satellite Launch Dimensions: (diam) 0.9 m (3.0 ft) (length) 2.1 m (7.0 ft) (vol) 1.4 m^3 (49.5 ft^3)

General Comments:

MISSION EQUIPMENT Code NC2-47

Weight: 18 kg (40 lb) Power: 70 W

Type of Experiment(s): Microwave radiometry, spectrometer, radiometric vertical sensor, composite radiometer-spectrometer, NANO-G accelerometer, millimeter wave propagation, altimeter, and data collection experiments

Purpose of Experiment(s): Provide early testing of critical subsystem, advanced sensors, and individual experiments

Type of Sensor(s): Communications transponders and antennas at various frequency bandwidths

Unique Sensor Requirements and Technology Status: None

Environmental Requirements: Natural

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.1 deg on all axes, 10 arc sec/sec drift rate

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NC2-47

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive system

Guidance and Navigation Requirements:

Propulsive Requirements: Stationkeeping

Type Propellant: N_2H_4 Thrust: 0.13 N(0.03 lb) - 12 thrusters

Orbit Adjust: Yes Total Impulse: 44,500 N-sec (10,000 lb-sec)

Apogee Kick Motor: Yes

Attitude Control: 3-axis, wheels

Pointing Accuracy: 0.1 deg Pointing Direction: TBD, exp dependent

Tracking, Telemetry and Command Requirements: Use USB system

Antennas: 2 to 4, 0.9 m (3 ft) diam, omni/earth coverage, S-band

Computers: Commands:

Type of Electrical Power System: Solar array and battery

Average Power: 100 W Peak Power: 150 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NC2-47

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: 12-48 hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Two satellites can be launched on same L/V; good to have man visit the satellites and make checkouts.

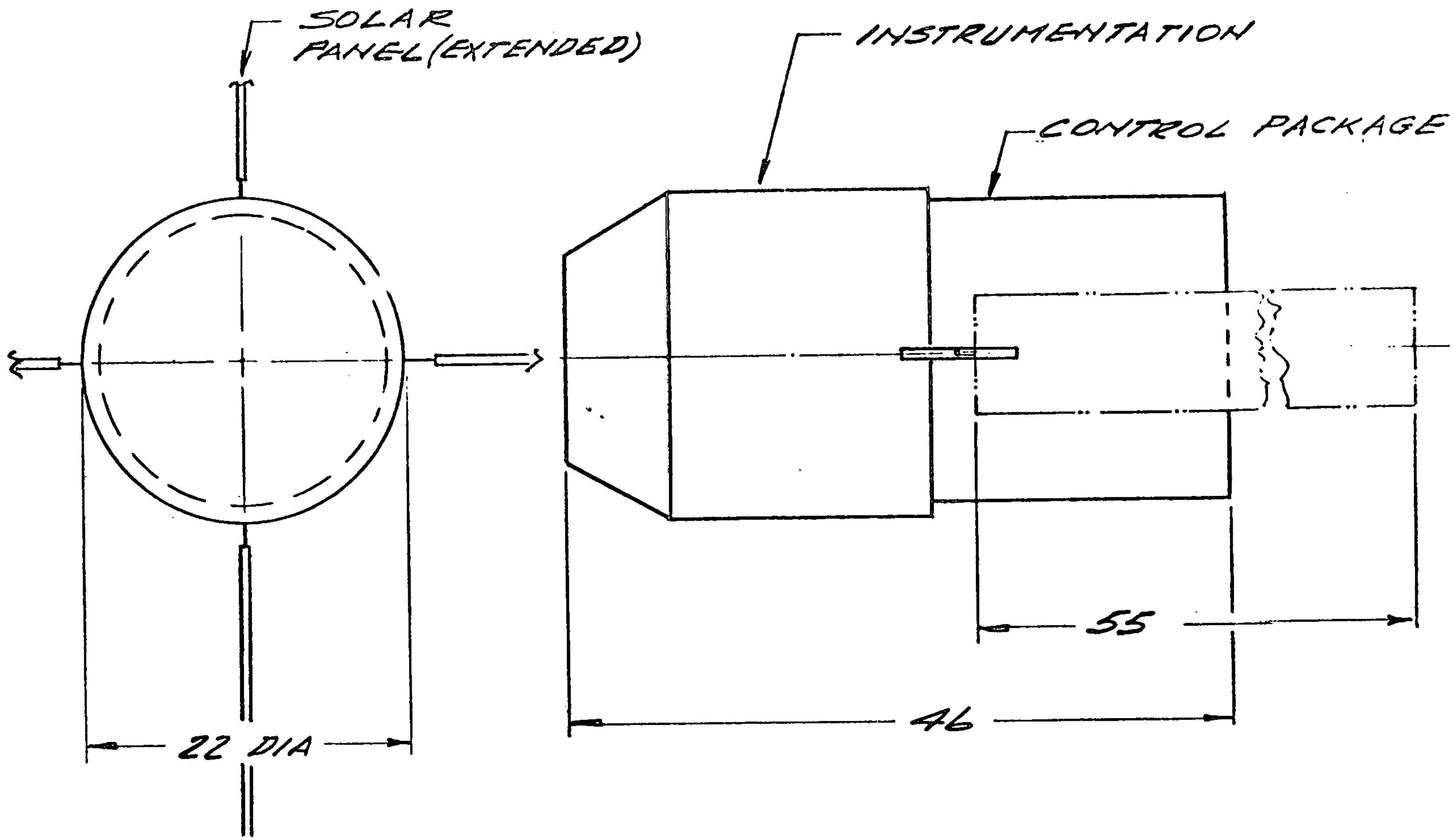
 Code NC2-47

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			25	(55)
Environmental Control			5	(10)
Guidance, Navigation, Stabilization			9	(20)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			16	(35)
Propellant	11	(25)		
Subsystem Dry	5	(10)		
Telemetry, Tracking, Command			14	(30)
Electrical, (100 W)			50	(110)
Batteries, Conversion, Conditioning	45	(100)		
Distribution	5	(10)		
Mission Equipment			18	(40)
Total Weight - Dry			126	(275)
Total Weight - Including Expendables			137	(300)
Adapter			7	(15)
Launch Weight			144	(315)

Comments:

Distribution based on statistical analysis; this is maximum weight; apogee motor not included. Weights based on expendable launch vehicle.

SMALL APPLICATIONS TECHNOLOGY SATELLITE



Delta class

PAYLOAD DATA SHEET

TITLE: Small Applications Technology Satellite - Polar

AGENCY: NASA/OA

CODE: NC2-48

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: D. Silverman

COGNIZANT SCIENTIST: ________

MISSION OBJECTIVES: Design, develop, launch, and operate a series of small R&D satellites for the experimental application of research and technology developments in spacecraft and sensor subsystems

Spacecraft Description: Provide low-cost, quick-reaction capabilities for one or two experiments per spacecraft

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
556^{+185}_{-37} (300^{+100}_{-20}) / 556 to $5,556^{+185}_{-37}$ (300 to $3,000^{+100}_{-20}$) / 90°

Launch Window: ________ days

Initial Launch Date: 1976 yr   No. of Satellites in System: 1

System Expected Lifetime: 1 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ________ %

Characteristic Velocity: 8,009* m/sec (26,275* ft/sec)

Satellite Weight: 136 kg (300 lb)

Satellite Launch Dimensions: (diam) 0.9 m (3.0 ft) (length) 2.1 m (7.0 ft) (vol) 1.4 m^3 (49.5 ft^3)

General Comments: *based on 556 km (300 nmi) circular orbit

MISSION EQUIPMENT Code NC2-48

Weight: 18 kg (40 lb) Power: 70 W

Type of Experiment(s): Precursor to observatory flights

Purpose of Experiment(s): Provide early testing of critical subsystem, advanced sensors, and individual experiments

Type of Sensor(s): Communications transponders and antennas at various frequency bandwidths

Unique Sensor Requirements and Technology Status: None

Environmental Requirements: Natural

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.8 deg on all axes, 10 arc sec/sec drift rate

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NC2-48

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive system

Guidance and Navigation Requirements:

Propulsive Requirements:

Type Propellant: N_2H_4 Thrust: 0.13 N (0.03 lb) - 12 thrusters

Orbit Adjust: Yes Total Impulse: 44,500 N-sec (10,000 lb-sec)

Apogee Kick Motor: No

Attitude Control: 3-axis, wheels

Pointing Accuracy: 0.1 deg Pointing Direction: TBD exp. dependent

Tracking, Telemetry and Command Requirements: Use USB system

Antennas: 2 to 4, 0.9 m (3 ft) dia, omni/earth coverage, S-band

Computers: Commands:

Type of Electrical Power System: Solar array and battery

Average Power: 100 W Peak Power: 200 W

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NC2-48

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: 12-48 hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Two satellites can be launched on same L/V; good to have man visit the satellites and make checkouts.

Code NC2-48

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			25	(55)
Environmental Control			5	(10)
Guidance, Navigation, Stabilization			9	(20)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			16	(35)
Propellant	11	(25)		
Subsystem Dry	5	(10)		
Telemetry, Tracking, Command			14	(30)
Electrical (100 W)			50	(110)
Batteries, Conversion, Conditioning	45	(100)		
Distribution	5	(10)		
Mission Equipment			18	(40)
Total Weight - Dry			125	(275)
Total Weight - Including Expendables			136	(300)
Adapter			7	(15)
Launch Weight			143	(315)

Comments:

Distribution based on statistical analysis; this is maximum weight; apogee motor not included. Weight based on expendable launch vehicle.

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PAYLOAD DATA SHEET

TITLE: Tracking and Data Relay Satellite (TDRS)

AGENCY: NASA/OS

CODE: NC2-49

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: G. Andrus

COGNIZANT SCIENTIST: ______

MISSION OBJECTIVES: Develop and demonstrate a world-wide tracking and data acquisition satellite to support low earth orbiting space missions

Spacecraft Description: Advanced INTELSAT IV

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323) / 35,784 (19,323) / $0^{\circ} \pm 3^{\circ}$

Launch Window: ______ days

Initial Launch Date: 1977 yr

No. of Satellites in System: 3

System Expected Lifetime: 12 yr

Satellite Mean Mission Duration: 5 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,685 ft/sec)

Satellite Weight: 798 kg (1,760 lb)

Satellite Launch Dimensions: (diam) 3.1 m (10.0 ft) (length) 5.2 m (17.0 ft) (vol) 37.8 m^3 (1,335.2 ft^3)

General Comments: Satellites spread 120 deg apart; TDRS is the operational version of the STS. See Ref. 26

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MISSION EQUIPMENT Code NC2-49

Weight: 99 kg (219 lb) Power: 300 W

Type of Experiment(s): Relay communications between near-earth satellites and small number of ground sites

Purpose of Experiment(s): Provide superior service through its unique capability for real-time access to the user spacecraft; real-time command and data recovery

Type of Sensor(s): Communication, command, and tracking; HF, VHF, and UHF sensors; laser; solid-state detectors; VHF, S-band, and X-band links to satellites; X-band link to ground

Unique Sensor Requirements and Technology Status: 100 Mbps downlink and auto-tracking antenna

Environmental Requirements:

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.1 deg

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NC2-49

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive system; insulation, coatings, and heaters; louvers for batteries

Guidance and Navigation Requirements:

Propulsive Requirements: Stationkeeping

Type Propellant: N_2H_4 Thrust: 0.13 N (0.03 lb)

Orbit Adjust: No Total Impulse: 311,400 N-sec (70,000 lb-sec)

Apogee Kick Motor: Yes

Attitude Control: Dual-spin

Pointing Accuracy: 0.1 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: VHF (136 - 138 MHz) with wideband antenna; also S-band (2,200 - 2,300 MHz) and Ku-band

Antennas:

Computers: Commands: 256-512 (32 bits) real-time and stored

Type of Electrical Power System: Solar array and battery

Average Power: 430 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NC2-49

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: 454 kg (1,000 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

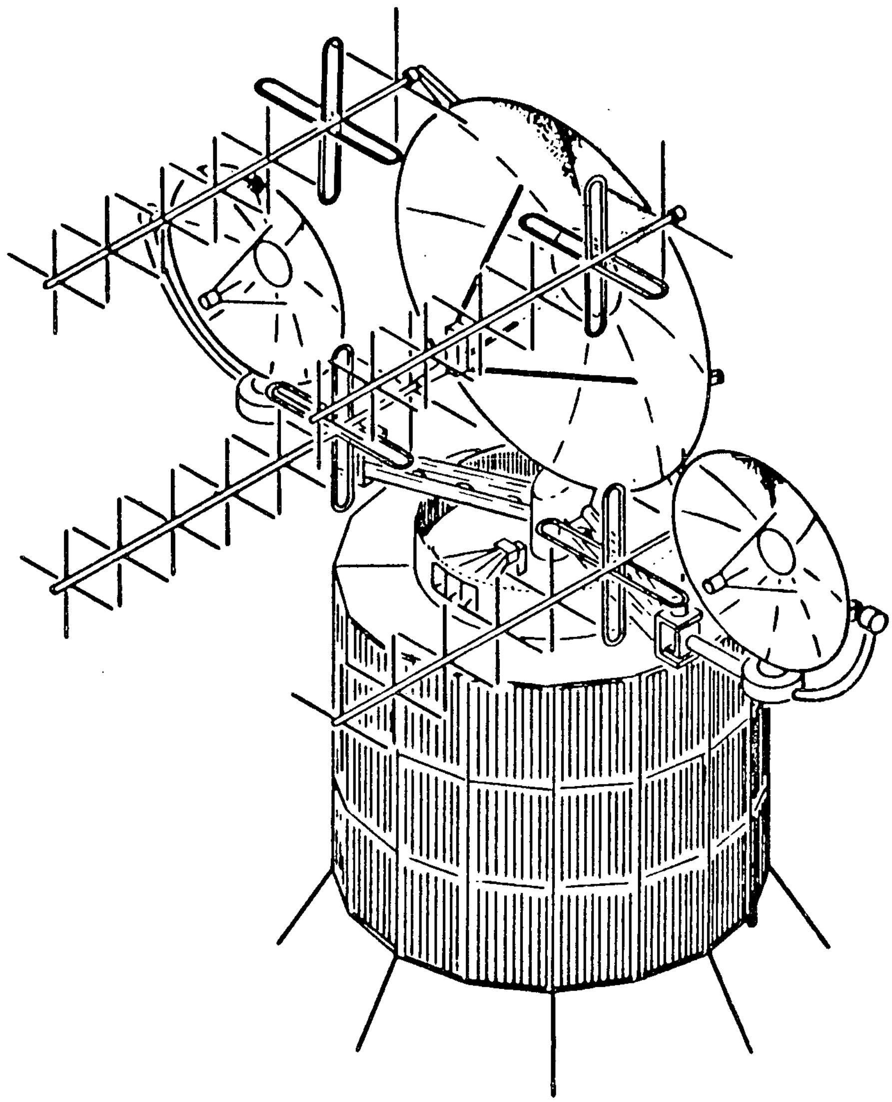
Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

 Code NC2-49

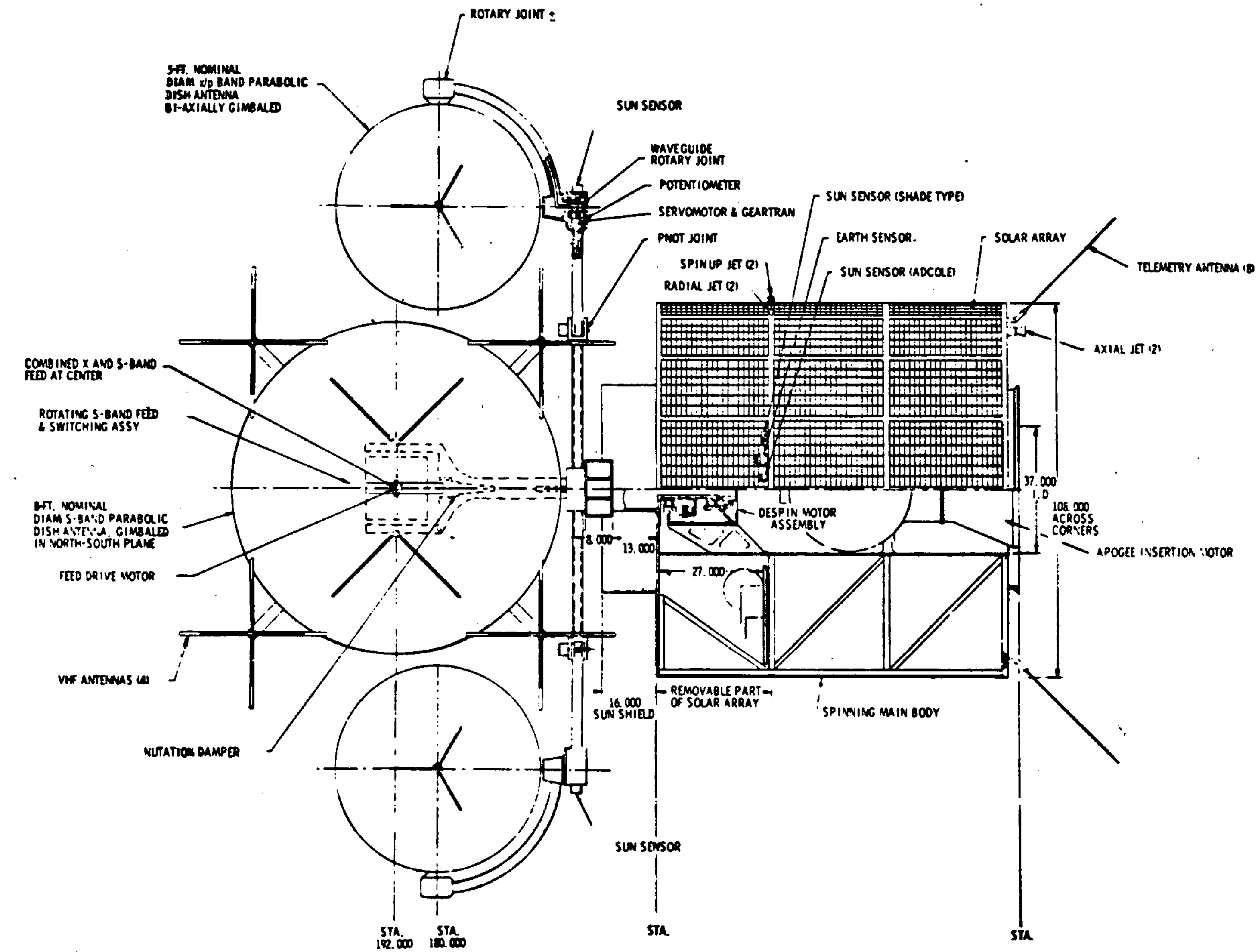
Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			70	(155)
Environmental Control			3	(7)
Guidance, Navigation, Stabilization			15	(34)
Propulsion			474	(1,045)
Propellant	442	(975)		
Subsystem Dry	32	(70)		
Attitude Control (Mass Expulsion)			46	(100)
Propellant	32	(70)		
Subsystem Dry	14	(30)		
Telemetry, Tracking, Command			0	(0)
Electrical			91	(200)
Batteries				
Conversion				
Conditioning				
Distribution				
Mission Equipment			99	(219)
Total Weight - Dry			324	(715)
Total Weight - Including Expendables			798	(1,760)
Adapter			40	(88)
Launch Weight			838	(1,848)

Comments: ____



Tracking and Data-Relay Satellite, Mk 1C

(Typical)



Tracking and Data Relay Satellite, Mk 1C
(Typical)

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PAYLOAD DATA SHEET

TITLE: Disaster Warning Satellite

AGENCY: NASA/OA

CODE: NC2-50

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: D. Silverman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Provide synchronous satellite to maintain continuous communication before, during, and after a disaster

Spacecraft Description: Prototype satellite

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 35,784 (19,323) / 35,784 (19,323) / $0^\circ \pm 3^\circ$

Launch Window: ______ days

Initial Launch Date: 1978 yr

No. of Satellites in System: 2

System Expected Lifetime: 15 yr

Satellite Mean Mission Duration: 5 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,684 ft/sec)

Satellite Weight: 798 kg (1,760 lb)

Satellite Launch Dimensions: (diam) 3.0 m (10.0 ft) (length) 5.2 m (17.0 ft) (vol) 37.8 m^3 (1,335.2 ft^3)

General Comments: The requirements will be generated by the Office of Emergency Planning (OEP) and the National Oceanic and Atmospheric Administration (NOAA)

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MISSION EQUIPMENT Code NC2-50

Weight: 227 kg (500 lb) Power: 700 W

Type of Experiment(s): Data transmission

Purpose of Experiment(s): To warn residents of possible disaster, provide communications during disaster, and direct the operations during the aftermath of a disaster

Type of Sensor(s): VHF, UHF, and SHF

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements:

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.15 deg pointing error, gimballed antennas

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NC2-50

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: One or more gimballed antennas, 0.05 deg accuracy

Propulsive Requirements: Stationkeeping

Type Propellant: N_2H_4 Thrust:

Orbit Adjust: Yes Total Impulse: 133,400 N-sec (30,000 lb-sec)

Apogee Kick Motor: No

Attitude Control: Momentum dump; 3-axis, wheels

Pointing Accuracy: 0.1 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: Use mission equipment frequency; telemetry data rate 10^3 - 10^4 Hz; command data rate 10^2 - 10^3 Hz; transmitter RF power output 23-33 dbm; no data processing

Antennas: 2 to 4, 0.15 to 0.9 m (0.5 to 3 ft), omni/earth coverage, mission frequency

Computers: None required Commands: 64-256 (8 bits)

Type of Electrical Power System: Solar array and battery

Average Power: 900 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE

Code NC2-50

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

Code NC2-50

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			168	(370)
Environmental Control			23	(50)
Guidance, Navigation, Stabilization			54	(120)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			81	(180)
Propellant	54	(120)		
Subsystem Dry	27	(60)		
Telemetry, Tracking, Command			54	(120)
Electrical			191	(420)
Batteries } Solar Array	127	(280)		
Conversion } Solar Array				
Conditioning	18	(40)		
Distribution	45	(100)		
Mission Equipment			227	(500)
Total Weight - Dry			744	(1,640)
Total Weight - Including Expendables			798	(1,760)
Adapter			40	(88)
Launch Weight			838	(1,848)

Comments: Total weight and total power specified; remaining weights based on statistical analysis. Weights based on expendable launch vehicle.

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PAYLOAD DATA SHEET

TITLE: System Test Satellites

AGENCY: NASA/OA

CODE: NC2-51

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: D. Silverman

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: System demonstration satellites for law enforcement, post office, air traffic control, maritime service, and land traffic control type missions

Spacecraft Description: Satellite technology being developed primarily under the ATS program

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
35,784 (19,323) / 35,784 (19,323) / $0^o \pm 3^o$

Launch Window: ______ days

Initial Launch Date: 1980 yr No. of Satellites in System: 2

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 5 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 12,096 m/sec (39,684 ft/sec)

Satellite Weight: 1,297 kg (2,860 lb)

Satellite Launch Dimensions: (diam) 3.7 m (12.0 ft) (length) 4.6 m (15.0 ft) (vol) 48.0 m^3 (1,696.5 ft^3)

General Comments: This program will be a continuing communication and navigation type mission through 1990; program is a system demonstration and will become operational when demonstration phase is completed; Space Shuttle is considered most likely launch vehicle.

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MISSION EQUIPMENT Code NC2-51

Weight: 143 kg (315 lb) Power: 500 W

Type of Experiment(s): Data relay

Purpose of Experiment(s): Develop and demonstrate a communications and traffic control system responsive to the requirements of specific users

Type of Sensor(s): VHF, UHF, SHF, EHF

Unique Sensor Requirements and Technology Status: EHF links; will use ATS technology

Environmental Requirements: Natural

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.2 deg

Propulsion Requirements: Stationkeeping

SUPPORTING SUBSYSTEMS Code NC2-51

Unique Structural Requirements: Exo type

Environmental Control Requirements: Passive

Guidance and Navigation Requirements: One or more gimballed antennas, 0.1 deg accuracy

Propulsive Requirements: Stationkeeping

Type Propellant: N_2H_4 Thrust:

Orbit Adjust: Yes Total Impulse: 133,400 N-sec (30,000 lb-sec)

Apogee Kick Motor: No

Attitude Control: 3-axis, wheels

Pointing Accuracy: 0.1 deg Pointing Direction: Earth

Tracking, Telemetry and Command Requirements: S-band

Antennas: 2 to 4, 0.15 to 0.9 m (0.5 to 3 ft), omni/earth coverage, mission beacon frequency

Computers: None required Commands: 64-256 (8 bits)

Type of Electrical Power System: "Oriented" solar array and battery

Average Power: 600 W Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE

Code NC2-51

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: Unscheduled

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable X

Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

 Code NC2-51

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			485	(1,070)
Environmental Control			59	(130)
Guidance, Navigation, Stabilization			157	(345)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			141	(310)
Propellant	95	(210)		
Subsystem Dry	45	(100)		
Telemetry, Tracking, Command			91	(200)
Electrical (600 W)			222	(490)
Batteries, Solar Array Included; Conversion, 70 lb Substrate	136	(300)		
Conditioning	18	(40)		
Distribution	68	(150)		
Mission Equipment			143	(315)
Total Weight - Dry			1,202	(2,650)
Total Weight - Including Expendables			1,297	(2,860)
Adapter			65	(143)
Launch Weight			1,362	(3,003)

Comments: Total weight and power specified; remaining subsystems based on statistical analysis. Based on expendable launch vehicle.

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PAYLOAD DATA SHEET

TITLE: Sortie-Communications/ Navigation Experiments

AGENCY: NASA/OA

CODE: NC2-52

PROGRAM: Communications & Navigation

COGNIZANT ENGINEER: E. Ehrlich

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Perform useful experiments related to natural environment measurement; demonstrate and test communications/navigation hardware, provide scientifically responsive laboratories; provide flexible facilities; and complement related activities

Spacecraft Description: Sortie can plus pallet combination is operated from a Shuttle orbiter in-bay position

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 370^{+741}_{-185} (200^{+400}_{-100})/ 370^{+741}_{-0} (200^{+400}_{-0}) / $28^{o}{}^{+27^{o}}_{-0^{o}}$

Launch Window: None days

Initial Launch Date: 1979 yr

No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,905 m/sec (25,935 ft/sec)

Satellite Weight: 8,124 kg (17,910 lb)

Satellite Launch Dimensions:* (diam) 4.3 m (14.0 ft) (length) 16.8 m (55.0 ft) (vol) 239.8 m^3 (8,466.6 ft^3)

General Comments: See Ref. 25, 27

* Sortie can 7.6 m (25.0 ft) + pallet 9.1 m (30.0 ft)

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MISSION EQUIPMENT Code NC2-52

Weight: 3,087 kg (6,806 lb) Power: 4.5 kW

Type of Experiment(s): RFI measurements and mapping; propagation; communications relay to TDRS; laser communications; fixed multibeam; antenna measurements; interferometric Nav. & Surv. techniques; and landmark tracking measurement

Purpose of Experiment(s): See attachment

Type of Sensor(s): Spectrum analyzer, oscillographic recorder, optical antenna, RF power meter, receiver, optical collimator, transmitter, frequency synthesizer

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: Optics sensitive to contamination and heat rejection = 25,000 Btu/hr

Data Processing and Transmission Requirements: Data storage = 1.2×10^9 bits; 1 mbps transmission

Attitude Control and Pointing Accuracy Requirements: 0.5° pointing and 0.1 deg/sec for 45 hrs/sortie mission

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NC2-52

Unique Structural Requirements: Birdcage type structure in pressurized sortie can on which to mount experiments

Environmental Control Requirements: 7-day manned system with 100,000 class air

Guidance and Navigation Requirements:

Propulsive Requirements: Orbiter

Type Propellant: Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control:

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: S-band, use Orbiter

Antennas: 1 LPDA, 1 multibeam, 1 laser telescope, 1 landmark tracking telescope, 1 VHF/UHF cross slotted, 1 8-ft Ku band disk, 2 L-band dipoles each on the end of a 32-ft boom

Computers: Central computer for experiments Commands:

Type of Electrical Power System: Orbiter

Average Power: 4.5 kW Peak Power: 9 kW

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NC2-52

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: Sortie

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace ______

Maintain ______ Operate ______

Stay Time Required: ______ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: Very little on-board maintenance/repair planned for early communications/navigation missions

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle mission will accelerate equipment technology development for future communications/navigation satellites

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures			5,037	(11,104)
Standard sortie can*	4,674*	(10,304)*		
Pallet	363	(800)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			0	(0)
Electrical			0	(0)
Conversion				
Conditioning				
Distribution				
Mission Equipment			3,087	(6,806)
Equip & frame	1,465	(3,230)		
Antennas, drive syst, & electronics	538	(1,185)		
Mission Support Consumables	1,085	(2,391)		
Total Weight			8,124	(17,910)
Launch Weight			8,124	(17,910)

Comments: * 645 kg (1,423 lb) for standard data management network and display is not included in this standard sortie can weight. See Ref. 27

Candidate Comm/Nav Experiment Classes and Their Objectives

EXPERIMENT CLASS	PURPOSE OF EXPERIMENTS
1. Terrestrial Sources of Noise and Interference	Map terrestrial noise and interference sources in operational and projected frequency bands of interest.
2. RF Propagation	Investigate RF propagation effects including multipath, scintillation, and Faraday rotation.
3. Communication Relay Tests	Evaluate equipment, procedures, and techniques related to communications via a data relay satellite (TDRS).
4. Laser Communications	Refine and extend laser technology space in applications at various optical frequencies.
5. Fixed Multibeam Antenna	Demonstrate and evaluate relative performance of competing multiple beam concepts in a space environment for: frequency reuse, polarization isolation, and beam and side lobe control.
6. Interferometric Navigation and Surveillance	Demonstrate the line-of-sight measurement accuracy of a long baseline spacecraft receiving interferometer as a candidate for future navigation or surveillance systems.
7 Landmark Tracking	Determine the feasibility and accuracy of autonomous navigation using unknown earth landmarks.

PAYLOAD DATA SHEET

TITLE: Sortie - Communications/ Navigation Laboratory   AGENCY: NASA/OA

CODE: NC2-53

PROGRAM: Communications & Navigation   COGNIZANT ENGINEER: E. Ehrlich

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Perform useful experiments related to natural environment measurement; demonstrate and test communications/navigation hardware, provide scientifically responsive laboratories; provide flexible facilities; and complement related activities

Spacecraft Description: Sortie can plus pallet attached to orbiter, but out of cargo bay; and deploy subsatellites* for experiment support

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: $370 \, {}^{+741}_{-185}$ ($200 \, {}^{+400}_{-100}$)/ $370 \, {}^{+741}_{-0}$ ($200 \, {}^{+400}_{-0}$)/$28^{o} \, {}^{+27^{o}}_{-0^{o}}$ (some orbits could be elliptical)

Launch Window: None days

Initial Launch Date: 1981 yr   No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 1/12 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,905 m/sec (25,935 ft/sec)

Satellite Weight: 7,943 kg (17,510 lb)

Satellite Launch Dimensions:** (diam) 4.3 m (14.0 ft) (length) 12.5 m (41.0 ft) (vol) 178.7 m^3 (6,311.5 ft^3)

General Comments: See Ref. 25, 27

* the subsatellites would remain in orbits for 1 to 2 years

** Sortie can 7.6 m (25 ft) plus antenna mounting arm 4.9 m (16 ft)

MISSION EQUIPMENT Code NC2-53

Weight: 3,269 kg (7,206 lb) Power: 4.5 kW

Type of Experiment(s): The same experiments described in NC2-52, plus 6 additional (see attachment)

Purpose of Experiment(s): See attachment for the objectives of the 13 experiments

Type of Sensor(s): Spectrum analyzer, oscillographic recorder, optical antenna, RF power meter, receiver, optical collimator, transmitter, frequency synthesizer

Unique Sensor Requirements and Technology Status: Modify commercial equipment for space use

Environmental Requirements: Optics sensitive to contamination

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements: 0.5 deg pointing and 0.01 deg/sec stability for 45 hr/sortie mission

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NC2-53

Unique Structural Requirements: Birdcage type structure in pressurized sortie can on which to mount experiment modules

Environmental Control Requirements: Manned system

Guidance and Navigation Requirements: ______

Propulsive Requirements: Orbiter

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: ______

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: Orbiter provided, S-band

Antennas: 1 LPDA, 1 multibeam, 1 laser telescope, 1 landmark tracking telescope, 1 VHF/UHF cross slotted, 1 8-ft Ku band disk, 2 L-band dipoles mounted on boom

Computers: Central computer Commands: ______

Type of Electrical Power System: Orbiter

Average Power: 4.5 kW Peak Power: 9 kW

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NC2-53

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______

Visits:

No. of Visits per Year: 1 visit to subsatellite

Payload per Visit: ______ kg (______ lb)

Purpose of Visit: Refurbish ______ Replace X

Maintain X Operate ______

Stay Time Required: 10 hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: On-orbit maintenance and ground refurbishment

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle missions will accelerate equipment technology development for future communications/navigation satellites.

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms Standard Sortie Can*			4,674	(10,304)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			0	(0)
Electrical Batteries Conversion Conditioning Distribution			0	(0)
Mission Equipment			3,269	(7,206)
Antennas, drive systems, electronics	538	(1,185)		
Deploy.boom & drive	181	(400)		
Equip. & frames	1,465	(3,230)		
Mission Support Consumables	1,085	(2,391)		
Total Weight			7,943	(17,510)
Launch Weight			7,943	(17,510)

Comments: * 645 kg (1,423 lb) for standard data management networks and displays is not included in this standard sortie can weight.

Candidate Comm/Nav Experiment Classes and Their Objectives

EXPERIMENT CLASS	PURPOSE OF EXPERIMENTS
1. Terrestrial Sources of Noise and Interference	Map terrestrial noise and interference sources in operational and projected frequency bands of interest.
2. Susceptibility of Terrestrial Systems to Satellite Radiations	Evaluate the magnitude of the interference experienced by terrestrial communication systems from transmissions by orbiting spacecraft.
3. RF Propagation	Investigate RF propagation effects including multipath, scintillation, and Faraday rotation.
4. Plasma Propagation	Investigate feasibility of transmitting signals from a re-entering vehicle via a relay satellite, instead of directly to the ground.
5. Communication Relay Tests	Evaluate equipment, procedures, and techniques related to communications via a data relay satellite (TDRS).
6. On-Board Data Processing	Demonstrate techniques to reduce interference, alleviate multipath, provide direct user control, and improve flexibility.
7. Laser Communications	Refine and extend laser technology space in applications at various optical frequencies.
8. Fixed Multibeam Antenna	Demonstrate and evaluate relative performance of competing multiple beam concepts in a space environment for: frequency reuse, polarization isolation, and beam and side lobe control.
9. Narrow Beam Tracking	Measure and optimize performance of ultra-narrow beam antennas for space-to-space communication applications.
10. Range and Range Rate Navigation and Surveillance	Demonstrate and evaluate range and range rate measuring techniques for future terrestrial navigation, surveillance, and search/rescue systems.
11. Interferometric Navigation	Demonstrate the line-of-sight measurement accuracy of a long baseline spacecraft receiving interferometer as a candidate for future navigation or surveillance systems.

EXPERIMENT CLASS	PURPOSE OF EXPERIMENTS
12. Landmark Tracking	Determine the feasibility and accuracy of autonomous navigation using unknown earth landmarks.
13. Horizon Altitude and Radiation Profile Measurements	Measure the spectral radiance profile of the earth, and especially the horizons, for application to earth-pointing systems.

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PAYLOAD DATA SHEET

TITLE: Space Station - (RAM) Communications/Navigation Laboratory AGENCY: NASA/OA

CODE: NC2-54

PROGRAM: Communications & Navigation COGNIZANT ENGINEER: E. Ehrlich

COGNIZANT SCIENTIST: ______

MISSION OBJECTIVES: Develop and demonstrate satellite systems and spacecraft technology; optimize the use of electromagnetic spectrum; and provide fundamental understanding of space communication and navigation science

Spacecraft Description: Communications/ navigation research facility attached to space station to support experimentation, data processing, and maintenance

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55°

Launch Window: Rendezvous days

Initial Launch Date: 1986 yr No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1/4 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7978 m/sec (26,174 ft/sec)

Satellite Weight: 16,556 kg (36,500 lb)

Satellite Launch Dimensions: (diam) 4.3 m (length) 13.7 m (vol) 196.2 m^3

(14.0 ft) (45.0 ft) (6,927.2 ft^3)

General Comments: See Ref. 25, 27

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MISSION EQUIPMENT Code NC2-54

Weight: 6,804 kg (15,000 lb) Power: 10 kW

Type of Experiment(s): 18 experiments (see attachment)

Purpose of Experiment(s): See attachment for objective of each experiment

Type of Sensor(s): Oscilloscope, wideband spectrum analyzer, noise generator, receiver, transmitter, modulator, telescope data processor, multiplexer, encoder/decoder, large antenna

Unique Sensor Requirements and Technology Status: Communication equipment/ development to be done especially on control and display devices

Environmental Requirements: Optics sensitive to contamination

Data Processing and Transmission Requirements: 1 to 10 Mbps transmission and on-board data processing

Attitude Control and Pointing Accuracy Requirements: Gimballed platform for various antennas

Propulsion Requirements: Space station

SUPPORTING SUBSYSTEMS Code NC2-54

Unique Structural Requirements: Manned laboratory, and large booms and deployable antennas; endo

Environmental Control Requirements: 3-month duration station

Guidance and Navigation Requirements: Gimbal mount experiment to 0.01 deg pointing, station pointing - 0.5 deg

Propulsive Requirements: None

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: ______

Pointing Accuracy: 0.01 deg Pointing Direction: 360 deg

Tracking, Telemetry and Command Requirements: S-band space station provided

Antennas: Large experimental antenna "farm" extending from lab module

Computers: Space station computer Commands: ______

Type of Electrical Power System: Station

Average Power: 10 kW Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NC2-54

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: *None

Payload per Visit: 2,268 kg (5,000 lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ____

Stay Time Required: 48 hr

Requirement for Retrieval:* Yes X No ____ Desirable ____

Expected Maintenance Philosophy: On-board maintenance by space station crew

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle can retrieve the laboratory and resupply

* Laboratory stay-time is 2 to 3 months

WEIGHTS

Code NC2-54

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			7,258	(16,000)
Structures	4,536	(10,000)		
Environ, Protection	1,361	(3,000)		
Antenna mounts	907	(2,000)		
Docking	454	(1,000)		
Environmental Control			907	(2,000)
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			227	(500)
Electrical			1,361	(3,000)
Conversion	907	(2,000)		
Conditioning				
Distribution				
Wiring	454	(1,000)		
Mission Equipment			6,804	(15,000)
Total Weight			16,556	(36,500)
Launch Weight			16,556	(36,500)

Comments: ______________________________

Candidate Comm/Nav Experiment Classes and Their Objectives

EXPERIMENT CLASS	PURPOSE OF EXPERIMENTS
1. Terrestrial Sources of Noise and Interference	Map terrestrial noise and interference sources in operational and projected frequency bands of interest.
2. Susceptibility of Terrestrial Systems to Satellite Radiations	Evaluate the magnitude of the interference experienced by terrestrial communication systems from transmissions by orbiting spacecraft.
3. RF Propagation	Investigate RF propagation effects including multipath, scintillation, and Faraday rotation.
4. Optical Propagation	Extend the knowledge of optical wavelength propagation phenomena in the atmosphere and free space.
5. Plasma Propagation	Investigate feasibility of transmitting signals from a re-entering vehicle via a relay satellite, instead of directly to the ground.
6. Direct Broadcast	Demonstrate feasibility of TV transmission from a satellite directly to the home viewer.
7. Communication Relay Tests	Evaluate equipment, procedures, and techniques related to communications via a data relay satellite (TDRS).
8. On-Board Data Processing	Demonstrates techniques to reduce interference, alleviate multipath, provide direct user control, and improve flexibility.
9. Laser Communications	Refine and extend laser technology space in applications at various optical frequencies.
10. ELF/VLF Antenna	Improve knowledge of radiation and propagation phenomena in the ionosphere at ELF/VLF frequencies.
11. Fixed Multibeam Antenna	Demonstrate and evaluate relative performance of competing multiple beam concepts in a space environment for: frequency reuse, polarization isolation, and beam and side lobe control.
12. Large Deployable Reflectors	Evaluate the deployment mechanism/sequence and performance of large deployable reflectors in space.
13. Narrow Beam Tracking	Measure and optimize performance of ultra-narrow beam antennas for space-to-space communication applications.
14. Range and Range Rate Navigation and Surveillance	Demonstrate and evaluate range and range rate measuring techniques for future terrestrial navigation, surveillance, and search/rescue systems.
15. Interferometric Navigation and Surveillance	Demonstrate the line-of-sight measurement accuracy of a long baseline spacecraft receiving interferometer as a candidate for future navigation or surveillance systems.
16. Landmark Tracking	Determine the feasibility and accuracy of autonomous navigation using unknown earth landmarks.
17. Laser Ranging	Evaluate utility and accuracy of an on-board laser ranging system for application with cooperative and uncooperative targets.
18. Horizon Altitude and Radiance Profile Measurements	Measure the spectral radiance profile of the earth, and especially the horizons, for application to earth-pointing systems.

IX. Life Science

PAYLOAD DATA SHEET

TITLE: Bio-Research Module

AGENCY: NASA/OMSF

CODE: NB2-55

PROGRAM: Life Science

COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To provide a means of conducting life science experiments in the weightless environment, to study the operational capabilities and process parameters of life support and protective systems equipment

Spacecraft Description: A module to serve as a vehicle to conduct the experiment

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:

556 (300) / 556 (300) / $28.5^{\circ}\,{}^{+10^{\circ}}_{-0^{\circ}}$

Launch Window: None days

Initial Launch Date: 1975 yr

No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 0.5 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8008 m/sec (26,274 ft/sec)

Satellite Weight: 168 kg (370 lb)

Satellite Launch Dimensions: (diam) 0.9 m (3.0 ft) (length) 1.5 m (5.0 ft)* (vol) 1.0 m^3 (35.3 ft^3)

General Comments: See Ref. 28

* size limited to Scout fairing envelope and payload capability

MISSION EQUIPMENT   Code NB2-55

Weight: 45 kg (100 lb)   Power: 50 W

Type of Experiment(s): To study the effect of the space environment on small mammals, cells, and tissues

Purpose of Experiment(s): The role of gravity in physiology, genetics, host parasite relations, and radiation effects

Type of Sensor(s): Biology, racks, life support, protective system

Unique Sensor Requirements and Technology Status:

Environmental Requirements: $50^{\circ} \pm 50^{\circ}F$

Data Processing and Transmission Requirements: 2,000 bps

Attitude Control and Pointing Accuracy Requirements: ± 5 deg

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NB2-55

Unique Structural Requirements: Exo

Environmental Control Requirements: Louver

Guidance and Navigation Requirements: ± 5 deg

Propulsive Requirements: Cold gas

Type Propellant: N_2 Thrust: _____

Orbit Adjust: No Total Impulse: _____ kg-sec (_____ lb-sec)

Apogee Kick Motor: No

Attitude Control: _____

Pointing Accuracy: ± 5 deg Pointing Direction: _____

Tracking, Telemetry and Command Requirements: 2,000 bps

Antennas: _____

Computers: _____ Commands: _____

Type of Electrical Power System: Solar cells and battery

Average Power: 100 W Peak Power: 200 W

Unique Interstage/Adapter Requirements: _____

SHUTTLE INTERFACE Code NB2-55

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 1

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: Remove experiment specimens

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Retrieve payloads for examination of specimens

Code NB2-55

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			18	(40)
Environmental Control Thermal Control			14	(31)
Guidance, Navigation, Stabilization			4	(9)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion)			17	(37)
Propellant	9	(20)		
Subsystem Dry	8	(17)		
Telemetry, Tracking, Command			15	(34)
Electrical, Solar cells 100W			54	(119)
Batteries & Cells	45	(100)*		
Conversion				
Conditioning				
Distribution	9	(19)		
Mission Equipment			45	(100)
Total Weight - Dry			159	(350)
Total Weight - Including Expendables			168	(370)
Adapter			23	(50)
Launch Weight			191	(420)

Comments: See Ref. 28

* weight increased over value supplied in reference document

PAYLOAD DATA SHEET

TITLE: Teleoperator

AGENCY: NASA/OMSF

CODE: NB2-56

PROGRAM: Life Science

COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To develop and evaluate an experimental teleoperator system which would be a precursor to an operational system

Spacecraft Description: A small free-flying spacecraft with manipulator arms and a control station in the Orbiter

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 556 (300) / 556 (300) / 28.5° $^{+10^{\circ}}_{-0^{\circ}}$ *

Launch Window: Rendezvous

Initial Launch Date: 1979 yr

No. of Satellites in System: 1

System Expected Lifetime: ______ yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 8008 m/sec (26,274 ft/sec)

Satellite Weight: 436 kg (960 lb)

Satellite Launch Dimensions: (diam) 1.2 m (4.0 ft) (length) 0.9 m (3.0 ft) (vol) 1.0 m^3 (35.3 ft^3)

General Comments: * same orbit as the Bio-Research Module

See Ref. 29, 30

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MISSION EQUIPMENT   Code NB2-56

Weight: 182 kg (402 lb) Power: 440 W

Type of Experiment(s): To evaluate teleoperator performance, safety, and suitability for performing various tasks in space

Purpose of Experiment(s): To retrieve the Bio-Research Module

Type of Sensor(s): Manipulator

Unique Sensor Requirements and Technology Status: Manipulator

Environmental Requirements: -100° to 200°F

Data Processing and Transmission Requirements: 3, 840 bps command & control, 5 MHz video

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NB2-56

Unique Structural Requirements: Endo

Environmental Control Requirements: Passive if possible

Guidance and Navigation Requirements: Fail-safe reaction to an emergency situation

Propulsive Requirements:

Type Propellant: Hydrazine Thrust:

Orbit Adjust: Total Impulse: ____ kg-sec (____ lb-sec)

Apogee Kick Motor:

Attitude Control: 3-axis

Pointing Accuracy: Docking Pointing Direction:

Tracking, Telemetry and Command Requirements: 3,840 bps command & control, 5 MHz analog for 2 TV channels

Antennas:

Computers: Commands:

Type of Electrical Power System: Battery

Average Power: Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NB2-56

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch _____ Post Launch _____

Support Requirement on Shuttle During Transportation:

Electrical ______________

Environment ______________

Checkout ______________

Other ______________

Visits:

No. of Visits per Year: 1

Payload per Visit: ______________ kg (______________ lb)

Purpose of Visit: Refurbish ________ Replace ________

Maintain ________ Operate ________

Stay Time Required: __________ hr

Requirement for Retrieval: Yes X No ______ Desirable ______

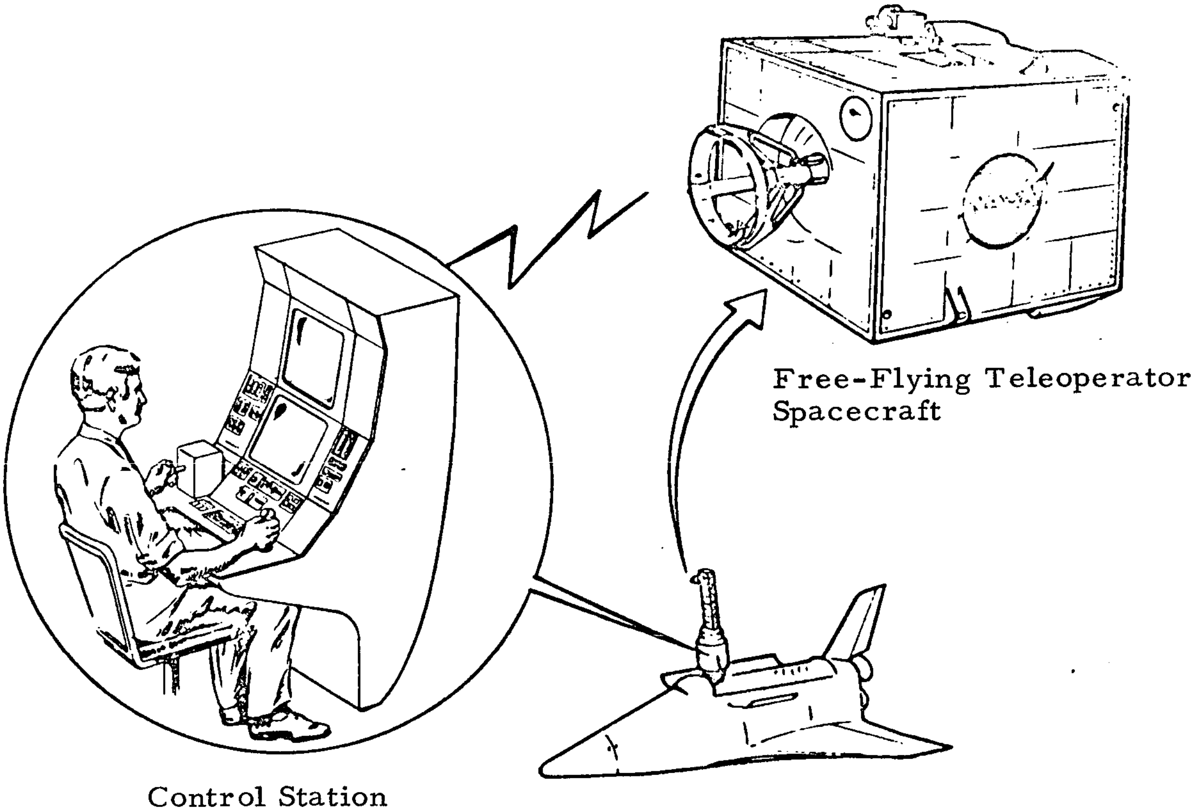
Expected Maintenance Philosophy: ____

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Man-controlled vehicle used to retrieve payloads for the Orbiter; no application for expendable launch vehicle

Code NB2-56

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Dock/Deploy			45	(100)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command	25	(54)	156	(342)
Data Recording	131	(288)		
Electrical Support			53	(116)
Batteries, Conversion, Conditioning, Distribution	5	(10)		
Display/control console	48	(106)		
Mission Equipment			182	(402)
Teleoperator - Dry	147	(325)		
Propellant	35	(77)		
Total Weight - Dry			401	(883)
Total Weight - Including Expendables			436	(960)
Adapter			9	(20)
Launch Weight			445	(980)

Comments: ______________________________



Free-Flying Teleoperator

PAYLOAD DATA SHEET

TITLE: Sortie - Mini 7-Day Module AGENCY: NASA/OMSF

CODE: NB2-57

PROGRAM: Life Science COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: (1) Medical and behavioral aspects with a manned orbital laboratory, (2) development, testing, and incorporation into such facilities, and (3) fundamental biological and biomedical research

Spacecraft Description: Attached RAM payload module

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Any orbit is acceptable; however, 463 (250)/ 463 (250)/0^{o} is preferred for radiation consideration only

Launch Window: None days

Initial Launch Date: 1980 yr No. of Satellites in System: 1

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7957 * m/sec (26,106* ft/sec)

Satellite Weight: 6,369 kg (14,041 lb)

Satellite Launch Dimensions: (diam) 4.3m (14.0 ft) (length) 9.8 m (32.0 ft) (vol) 139.5 m^3 (4,926.0 ft^3)

General Comments: Only the payload module of RAM Life Science Lab (Mini 7) is included. The RAM service module is not included since the Shuttle has an equivalent space in the Orbiter. *Based on 463 km (250 nmi) circular 28.5^{o} inclination orbit.

See Ref. 7

MISSION EQUIPMENT Code NB2-57

Weight: 2,293 kg (5,056 lb) Power: 3.3 kW

Type of Experiment(s): Plants, cells and tissues, invertebrates, life support/ protection system, and man-system integration

Purpose of Experiment(s): See Mission Objectives

Type of Sensor(s): Psychometry console, centrifuge, radiation source storage, electrophysiology console, behavior measurement, remote manipulator, refrigerator

Unique Sensor Requirements and Technology Status: Modify for space usage

Environmental Requirements: Shirtsleeve, $\leq 10^{-5}$ g

Data Processing and Transmission Requirements: 10^5 Mb/day

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NB2-57

Unique Structural Requirements: Racks, shelves, and modules

Environmental Control Requirements: Manned system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: None Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: None

Pointing Accuracy: None Pointing Direction:

Tracking, Telemetry and Command Requirements: Orbiter - 300 bps

Antennas: Orbiter

Computers: Commands:

Type of Electrical Power System:

Average Power: 3.3 kW Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NB2-57

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: ____

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: Refurbish and reuse

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Sortie mission

Code NB2-57

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms			3,536	(7,795)
Structures	2,459	(5,421)		
Env. Protection	969	(2,136)		
Docking	108	(238)		
Environmental Control			266	(586)
Atmos. & Env. Control	147	(325)		
Life Support & Interiors	118	(261)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command (Data Mgmt)			84	(186)
Electrical			190	(418)
Wiring	109	(240)		
Conversion, Conditioning, Distribution	73	(160)		
Checkout	8	(18)		
Mission Equipment			2,293	(5,056)
Interface Equip	77	(169)		
Gen Purpose Support	919	(2,027)		
Experiments	684	(1,419)		
Equipment Integ.	352	(777)		
Expendables	301	(664)		
Total Weight - Dry			6,068	(13,377)
Total Weight - Including Expendables			6,369	(14,041)
Crew Equipment & Residuals			454	(1,001)
Launch Weight			6,823	(15,042)

Comments:

The RSM is not included since the Orbiter provides space for habitability and test equipments.

PAYLOAD DATA SHEET

TITLE: Sortie - Mini 30-Day Module   AGENCY: NASA/OMSF

CODE: NB2-58

PROGRAM: Life Science   COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: 1) Medical and behavioral aspects of a manned orbital laboratory, 2) development, testing, and incorporation into such facilities, and 3) fundamental biological and biomedical research

Spacecraft Description: Attached RAM payload module

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Any orbit is acceptable; however, 463 (250) / 463 (250) / 0^{o} is preferred for radiation consideration.

Launch Window: None days

Initial Launch Date: 1983 yr   No. of Satellites in System: 1

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 1/12 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: 7,957* m/sec (26,106* ft/sec)

Satellite Weight: 8,569 kg (18,891 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 9.8 m (32.0 ft) (vol) 139.5 m^3 (4,926.0 ft^3)

General Comments: Only the payload module of RAM Life Science Lab (Mini-7) is included. The RAM service module is not included since the Shuttle has an equivalent space in the Orbiter.

* Based on 463 km (250 nmi) circular x 28.5^{o} inclination orbit.

MISSION EQUIPMENT Code NB2-58

Weight: 4,493 kg (9,906 lb) Power: 3.3 kW

Type of Experiment(s): Medical - man, vertebrates, primates, plants, cells and tissues, invertebrates, life support, and manned system integration

Purpose of Experiment(s): See Mission Objectives

Type of Sensor(s): Behavior measurement console, electrophysiology, centrifuge, toxic fluid handling, psychometer performance console, radiation source storage, and hold units

Unique Sensor Requirements and Technology Status:

Environmental Requirements: 10^{-5} g 95% of time

Data Processing and Transmission Requirements: 500 bps digital and 3×10^5 Mb/day TV

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NB2-58

Unique Structural Requirements: Racks, shelves, and modules

Environmental Control Requirements: Manned system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: None Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor: None

Attitude Control: None

Pointing Accuracy: None Pointing Direction:

Tracking, Telemetry and Command Requirements: 4×10^6 bps

Antennas:

Computers: Commands:

Type of Electrical Power System: Orbiter

Average Power: 3.3 kW Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NB2-58

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch _____ Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______________

Visits:

No. of Visits per Year: ______________

Payload per Visit: ______________ kg (______________ lb)

Purpose of Visit: Refurbish ________ Replace ________

Maintain ________ Operate ________

Stay Time Required: __________ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: Mission equipment to be mounted on racks and modular for refurbishment, replace, and repair

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______________

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			3,536	(7,795)
Structures	2,459	(5,421)		
Env. Protection	969	(2,136)		
Docking	108	(238)		
Environmental Control			266	(586)
Atmos. & Env. Control	147	(325)		
Life Supp. & Interiors	118	(261)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command (Data Mgmt.)			84	(186)
Electrical			190	(418)
Wiring	109	(240)		
Conversion / Conditioning / Distribution	73	(160)		
Checkout	8	(18)		
Mission Equipment			4,493	(9,906)
Interface Equip.	363	(801)		
Gen. Purpose Equip.	1,474	(3,249)		
Specific Exp. Equip.	1,775	(3,913)		
Support & Rack	470	(1,035)		
Expendables	412	(908)		
Total Weight - Dry			8,157	(17,983)
Total Weight - Including Expendables			8,569	(18,891)
Crew Equipment & Residuals			454	(1,001)
Launch Weight			9,023	(19,892)

Comments: The subsystems, except for the mission equipment, are the same as the Mini 7-Day Module. Mission equipment weights are extracted from Ref. 10

PAYLOAD DATA SHEET

TITLE: Space Station - Mini 30-Day Module   AGENCY: NASA/OMSF

CODE: NB2-59

PROGRAM: Life Science   COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: (1) Medical and behavior aspects of a manned orbital laboratory, (2) development, testing, and incorporation into such facilities, and (3) fundamental biological and biomedical research

Spacecraft Description: Short duration RAM payload module attached to space station

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270)/500 (270)/55°

Launch Window: Rendezvous with space station

Initial Launch Date: 1985 yr   No. of Satellites in System: 1

System Expected Lifetime: 2 yr

Satellite Mean Mission Duration: 1/12 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7978 m/sec (26,174 ft/sec)

Satellite Weight: 12,055 kg (26,576 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 9.8 m (32.0 ft) (vol) 139.5 m^3 (4,926.0 ft^3)

General Comments: The RAM Midi-30 and the combined mission equipment without duplicating components from F Module and BLH Module are used for this payload. It is assumed that the combined mission equipment can be accommodated in one module.

See Ref. 7

MISSION EQUIPMENT Code NB2-59

Weight: 7,084 kg (15,618 lb) Power: 5.5 kW

Type of Experiment(s): Medical, vertebrates, plants, cells and tissues, invertebrates, life support, and man-system integration

Purpose of Experiment(s): To test the life science laboratory facility and to conduct fundamental biological and biomedical research

Type of Sensor(s): Psychometry, electrophysiology, centrifuge, radiation source, manipulator, hold units

Unique Sensor Requirements and Technology Status:

Environmental Requirements: $\leq 10^{-5}$ g for 95% of orbital time, shirtsleeve environment

Data Processing and Transmission Requirements: 16 kbps digital and 24 hours high resolution TV

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS   Code NB2-59

Unique Structural Requirements: Racks, shelves, and modules

Environmental Control Requirements: Manned system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: None   Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: None

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: 4×10^6 bps

Antennas: ______

Computers: ______ Commands: ______

Type of Electrical Power System: Orbiter

Average Power: 5.5 kW   Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NB2-59

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch _____ Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ______________

Visits:

No. of Visits per Year: ______________

Payload per Visit: ______________ kg (______________ lb)

Purpose of Visit: Refurbish ________ Replace ________

Maintain ________ Operate ________

Stay Time Required: __________ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

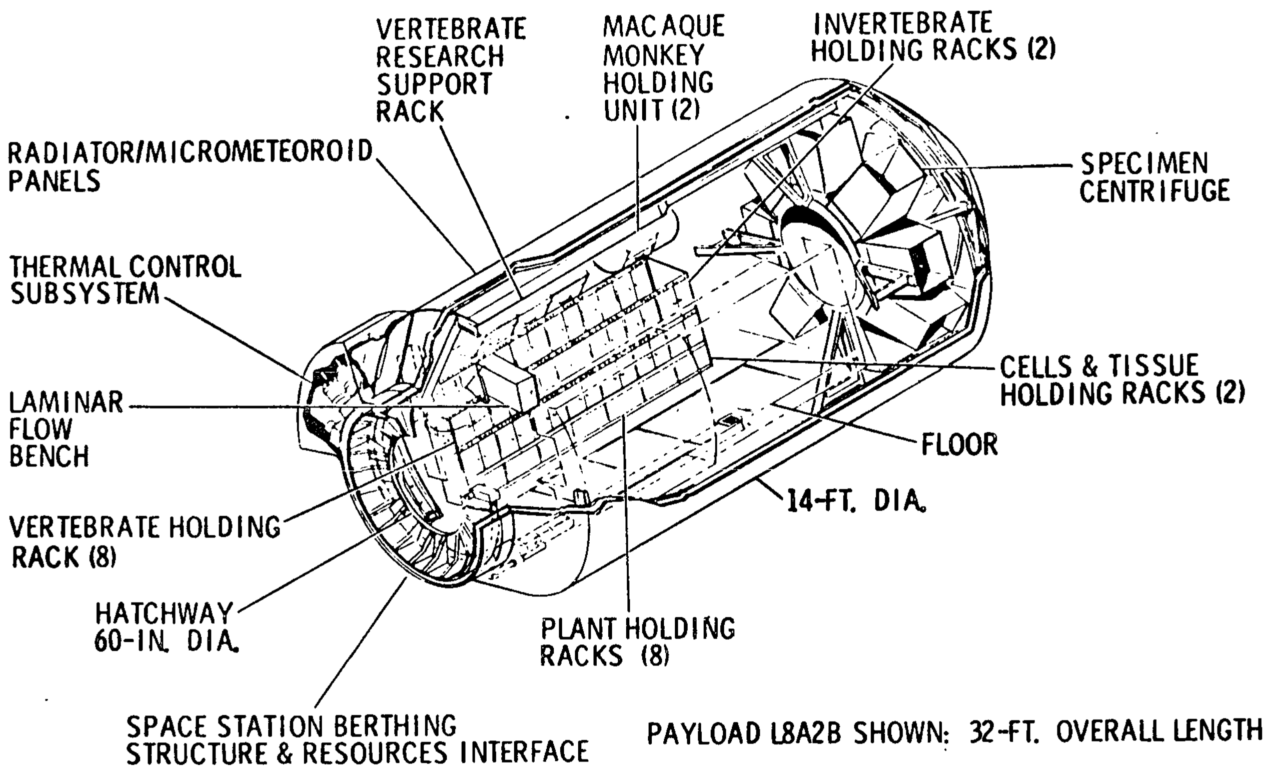
Expected Maintenance Philosophy: Mission equipment to be mounted on racks and modules for change out, replacement, and investigation

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ______________

Code NB2-59

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			3,661	(8,072)
Structures	2,576	(5,680)		
Meteoroid & Thermal Protection	977	(2,154)		
Docking	108	(238)		
Environmental Control			898	(1,979)
Atmos. & Thermal Control	535	(1,179)		
Fluids	363	(800)		
Guidance, Navigation Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			69	(152)
Electrical			343	(755)
Batteries	234	(515)		
Conversion / Conditioning / Distribution	109	(240)		
Mission Equipment			7,084	(15,618)
Interface Equip.	472	(1,041)		
Gen. Purpose Equip.	1,778	(3,919)		
Special Equip.	3,337	(7,356)		
Equip. Apparatus	227	(500)		
Integ. Equip.	743	(1,638)		
Expendables	528	(1,164)		
Total Weight - Dry			11,527	(25,412)
Total Weight - Including Expendables			12,055	(26,576)
Crew Equipment & Life Support			186	(410)
Launch Weight			12,241	(26,986)

Comments:



L8A2B-1 Station-Attached RAM Payload Module

PAYLOAD DATA SHEET

TITLE: Space Station - Life Science Laboratory

AGENCY: NASA/OMSF

CODE: NB2-60

PROGRAM: Life Science

COGNIZANT ENGINEER: R. W. Dunning

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: (1) Biomedicine - qualification of man for extended space mission, (2) Space Biology - establish interspecies relationships in response to space environment, (3) Life Support - acquisition of engineering data for manned spacecraft design

Spacecraft Description: Long-duration life sciences laboratory attached to space station

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270)/500 (270)/55°

Launch Window: * days

Initial Launch Date: 1987 yr

No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: 7978 m/sec (26,174 ft/sec)

Satellite Weight: 13,147 kg (28,984 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 9.8 m (32.0 ft) (vol) 139.5 m^3 (4,926.0 ft^3)

General Comments: * rendezvous with space station

See Ref. 7

MISSION EQUIPMENT Code NB2-60

Weight: 8, 177 kg (18, 026 lb) Power: 5.8 kW

Type of Experiment(s): Medical, vertebrates, plants, cells and tissues, invertebrates, life support, and man-system integration

Purpose of Experiment(s): To conduct fundamental biological and biomedical research, and to test and develop life support, protective system, and man-system integration

Type of Sensor(s): Centrifuge, toxic fluid handling, spectroheliograph, camera, microscope, radiation detector, behavior unit, incubator cells

Unique Sensor Requirements and Technology Status:

Environmental Requirements: Shirtsleeve environment and $\leq 10^{-5}$ g 95% of orbital time

Data Processing and Transmission Requirements: 16 kbps and TV

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

Code NB2-60

Unique Structural Requirements: Endo

Environmental Control Requirements: Manned long duration system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: None Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: None

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: 16 kbps

Antennas:

Computers: Commands:

Type of Electrical Power System:

Average Power: 5.8 kW Peak Power:

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE

Code NB2-60

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 6

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

Expected Maintenance Philosophy: On-orbit maintenance and on-ground refurbishment

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ___

Code NB2-60

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			3,661	(8,072)
Structures	2,576	(5,680)		
Meteoroid & Thermal Protection	977	(2,154)		
Docking	108	(238)		
Environmental Control			898	(1,979)
Atmos. & Thermal Control	535	(1,179)		
Fluids	363	(800)		
Guidance, Navigation Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			69	(152)
Electrical			343	(755)
Batteries				
Conversion	234	(515)		
Conditioning				
Distribution	109	(240)		
Mission Equipment			8,177	(18,026)
Interface Equip	467	(1,030)		
Gen Purpose Supp Equip	1,920	(4,232)		
Special Equip Support	3,925	(8,652)		
Experiment Apparatus	227	(500)		
Integ. Equipment	879	(1,938)		
Expendables	759	(1,674)		
Total Weight - Dry			12,388	(27,310)
Total Weight - Including Expendables			13,147	(28,984)
Crew Equipment & Life Support			186	(410)
Launch Weight			13,333	(29,394)

Comments:

X. Space Technology
and Material Science

PAYLOAD DATA SHEET

TITLE: Meteoroid & Exposure Module

AGENCY: NASA/OMSF

CODE: NT2-61

PROGRAM: Space Technology and Material Science

COGNIZANT ENGINEER: D. Novik

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: To expose various samples to solar environment

Spacecraft Description: Passively controlled hollow structural cylinder, mounted in Shuttle cargo without the use of pallet

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:
500 (270) / 500 (270) / 28.5° *

Launch Window: None days

Initial Launch Date: 1978 yr   No. of Satellites in System: 1

System Expected Lifetime: 0.5 yr

Satellite Mean Mission Duration: 0.5 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: 7978 m/sec (26,174 ft/sec)

Satellite Weight: 4,536 kg (10,000 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 10.7 m (35.0 ft) (vol) 152.6 m^3 (5,387.8 ft^3)

General Comments: * Nominal. Orbital requirement is to maintain a 6-month orbital life.

MISSION EQUIPMENT Code NT2-61

Weight: 698 kg (1,540 lb) Power: 0 W

Type of Experiment(s): Test solar cells, biological specimens, meteoroid bumpers, materials, and seedlings

Purpose of Experiment(s): To determine the effect of solar/space environment on various samples

Type of Sensor(s): Material panels, integrating dosimeter, and specimens

Unique Sensor Requirements and Technology Status: State-of-the-art

Environmental Requirements: None

Data Processing and Transmission Requirements: None

Attitude Control and Pointing Accuracy Requirements: Passively stable; tumbling rate to be within Shuttle retrieval capability

Propulsion Requirements: None

SUPPORTING SUBSYSTEMS Code NT2-61

Unique Structural Requirements: Exo, inexpensive structural design, ring frame-stringer

Environmental Control Requirements: None

Guidance and Navigation Requirements: Beacon for ground tracking and Shuttle rendezvous

Propulsive Requirements: None

Type Propellant: None Thrust: ____

Orbit Adjust: ____ Total Impulse: ____ kg-sec (____ lb-sec)

Apogee Kick Motor: ____

Attitude Control: Partial gravity gradient

Pointing Accuracy: Shuttle retrieval Pointing Direction: ____

Tracking, Telemetry and Command Requirements: None

Antennas: None

Computers: None Commands: ____

Type of Electrical Power System: None

Average Power: ____ Peak Power: ____

Unique Interstage/Adapter Requirements: ____

SHUTTLE INTERFACE Code NT2-61

Compatibility with Other Spacecraft in Shuttle: Yes X No ______

Access to Spacecraft in Shuttle Required: Prelaunch _____ Post Launch _____

Support Requirement on Shuttle During Transportation:

Electrical ______________

Environment ______________

Checkout ______________

Other ______________

Visits:

No. of Visits per Year: ______________

Payload per Visit: ______________ kg (______________ lb)

Purpose of Visit: Refurbish ________ Replace ________

Maintain ________ Operate ________

Stay Time Required: __________ hr

Requirement for Retrieval: Yes ______ No ______ Desirable ______

Expected Maintenance Philosophy: Retrieve, remount new experiments, and reuse spacecraft; retrieval to be accomplished with Shuttle Manipulator; space available to include hard-docking mechanism

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Retrieve and reuse spacecraft

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures and Ballast			3,838	(8,460)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			0	(0)
Electrical Batteries Conversion Conditioning Distribution			0	(0)
Mission Equipment Dosimeter Panels *	 18 680	 (40) (1,500)	698	(1,540)
Total Weight			4,536	(10,000)
Adapter			0	(0)
Launch Weight			4,536	(10,000)

Comments: * Panels are meteoroid bumpers, solar cells, materials, and specimens mounted on frame.

PAYLOAD DATA SHEET

TITLE: Material Science Experiments - Sortie

AGENCY: NASA/OMSF

CODE: NT2-62

PROGRAM: Space Technology and Material Science

COGNIZANT ENGINEER: J. Bredt

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Conduct a diversified experiment program to acquire data needed for processing inventions and development, and evolve apparatus technology and experimental techniques for space station operations

Spacecraft Description: Configure experiments into five modules to utilize any available space on all missions *

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Any orbit **

Launch Window: None days

Initial Launch Date: 1979 yr

No. of Satellites in System: **

System Expected Lifetime: 0.5 yr

Satellite Mean Mission Duration: 0.5 yr

Satellite Desired Availability: ____ %

Characteristic Velocity: ** m/sec (** ft/sec)

Satellite Weight: 1,234 kg (2,720 lb)

Satellite Launch Dimensions: (diam) 2.1 m (7.0 ft) (length) 3.0 m (10.0 ft)*** (vol) 10.9 m^3 (384.8 ft^3)

General Comments: * Use of pallet concept will hinder the flexible utilization needed for the program's experiment approach. ** Piggy back preferred.

*** Size data for each unit are provided in attachment.

See Ref. 29

MISSION EQUIPMENT   Code NT2-62

Weight: 1,234 kg (2,720 lb)   Power: 5.3 kW*

Type of Experiment(s): Biological, levitation, and furnace

Purpose of Experiment(s): To acquire data on metallurgy, crystal growth, biological applications, glass technology, and physical and chemical processes in fluids.

Type of Sensor(s): Electrophoresis, crystal growth, high temperature furnace, and incubator

Unique Sensor Requirements and Technology Status: None

Environmental Requirements: 10^{-4} g acceleration limit

Data Processing and Transmission Requirements: 10^3 bps digital data, voice communication, motion pictures, and TV

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements: None

* If all experiments are operating simultaneously

SUPPORTING SUBSYSTEMS Code NT2-62

Unique Structural Requirements: Units are built up of modules. Exo.

Environmental Control Requirements: Units are self controlled.

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: None Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: None

Pointing Accuracy: None Pointing Direction:

Tracking, Telemetry and Command Requirements: Orbiter communication

Antennas: Orbiter

Computers: Self contained Commands:

Type of Electrical Power System: Orbiter

Average Power: 5,250 W * Peak Power:

Unique Interstage/Adapter Requirements:

* If all experiments are operating simultaneously

SHUTTLE INTERFACE Code NT2-62

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch ____

Support Requirement on Shuttle During Transportation:

Electrical ____

Environment ____

Checkout ____

Other ____

Visits:

No. of Visits per Year: ____

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: Experiments are modular for reuse.

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Crew will act as skilled laboratory technicians serving the needs of many different research groups on the ground.

WEIGHTS Code NT2-62

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			0	(0)
Environmental Control			0	(0)
Guidance, Navigation, Stabilization			0	(0)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			0	(0)
Telemetry, Tracking, Command			0	(0)
Electrical Batteries Conversion Conditioning Distribution			0	(0)
Mission Equipment*			1,234	(2,720)
Biological	313	(690)		
Levitation	299	(660)		
Furnace	181	(400)		
General Purpose	100	(220)		
Support Equipment	340	(750)		
Total Weight			1,234	(2,720)
Adapter			0	(0)
Launch Weight			1,234	(2,720)

Comments: * This is a nominal list. Additional modules can be added or reduced, depending on Orbiter space available. See attachment for weight size data.

Code NT2-62

MATERIAL SCIENCE AND MANUFACTURING

SORTIE PAYLOADS	Unit Weight kg	(lb)	Size (DxL) m	(ft)	Avg. Power W
1. Biological - separation and preservation	313	(690)	1.68 x 0.61	5.5 x 2	700
2. Levitation - glasses, supercooling, and crystal	299	(660)	1.83 x 0.61	6 x 2	2,200
3. Furnace - composite and directional solidification	182	(400)	1.5 x 0.61	5 x 2	1,360
4. Small and Low Temperature - physics of fluids	100	(220)	1.5 x 0.61	5 x 2	350
SUBTOTAL	893	(1,970)	1.8 x 2.4	6 x 8	4,610
5. Support Equipment (Core)*					
Instr. and Control	68	(150)	0.61 x 2.7	2 x 9	200
Atmos. Sup. & Cont.	34	(75)	0.61 x 0.3	2 x 1	50
Power Cond.	91	(200)	0.5 x 1	1.5 x 3	60
Process Cont. Computer	34	(75)	0.5 x 0.6	1.5 x 2	300
Cleanup and Refurb. Eqt.	12	(26)	0.5 x 1	1.5 x 3	30
Oper. Mtl. & Fl. Storage	34	(75)	1 x 0.6	3 x 2	0
Atmos. Fluid Storage	48	(105)	1 x 1.5	3 x 5	0
Accident Control	20	(44)	0.61 x 1	2 x 3	0
SUBTOTAL	341	(750)	2.1 x 0.6	7 x 2	640
TOTAL	1,234	2,720	2.1 x 3.1	7 x 10	5,250

* One complete support equipment (core) is required for one or four sortie payload units.

PAYLOAD DATA SHEET

TITLE: Sortie - Advanced Technology Experiments AGENCY: NASA/OAST

CODE: NT2-63

PROGRAM: Space Technology & Material Science COGNIZANT ENGINEER: D. Novik

COGNIZANT SCIENTIST: R. Hook

MISSION OBJECTIVES: Provide orbiting facility to stimulate the development of new technology and demonstrate applications of space technology to meet the future needs of the nation.

Spacecraft Description: Manned module with racks and airlock for accommodating experiments in small modules

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 463 (250) x 463 (250 x $28.5^{\circ} \pm {}^{60^{\circ}}_{0^{\circ}}$

Launch Window: None days

Initial Launch Date: 1980 yr No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 1/50 yr

Satellite Desired Availability: ______ %

Characteristic Velocity: 7,957 m/sec (26,106 ft/sec)

Satellite Weight: 6,251 kg (13,781 lb)

Satellite Launch Dimensions:* (diam) 4.3m (14.0 ft) (length) 14.5 m (47.5 ft) (vol) 207 m^3 (7,310 ft^3)

General Comments: *Sortie RAM with 5.3 m (17.5 ft) airlock and 9.1 m (30.0 ft) pallet

See Ref. 35

MISSION EQUIPMENT — Code NT2-63

Weight: 2,683 kg (5,914 lb) Power: 3 kW W

Type of Experiment(s): Communications/navigation and earth observations are considered most likely types of experiments.

Purpose of Experiment(s): Exploration of new concepts and instrumentation to obtain measurements which test analytical models and provide an engineering base for developing future operational systems

Type of Sensor(s): Interferometer, antenna booms, oscilloscope, signal generator, laser, camera, tracker, inertial platform, TV

Unique Sensor Requirements and Technology Status: Experiments are in various degrees of development.

Environmental Requirements: 10^{-4} g

Data Processing and Transmission Requirements: 10^4 bps real time transmission and 3.5×10^{11} bpd

Attitude Control and Pointing Accuracy Requirements: 2 deg pointing and 10^{-5} rad/sec

Propulsion Requirements: None

 Code NT2-63

Unique Structural Requirements: Module, pallet, and 76.2 m (250 ft) booms

Environmental Control Requirements: Short duration manned system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: ______

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S-band

Antennas: Orbiter

Computers: ______ Commands: ______

Type of Electrical Power System: Orbiter

Average Power: 3 kW Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NT2-63

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: ____

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish ____ Replace ____

Maintain ____ Operate ____

Stay Time Required: ____ hr

Requirement for Retrieval: Yes ____ No ____ Desirable ____

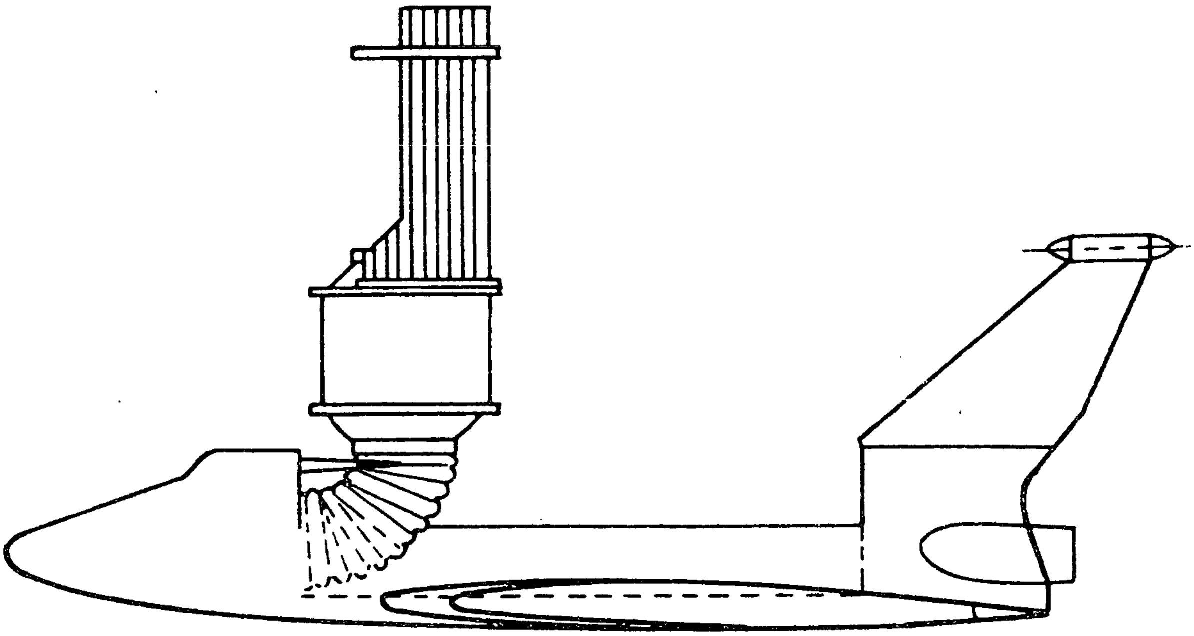
Expected Maintenance Philosophy: On-board maintenance and ground refurbishment

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Sortie possible only with Shuttle

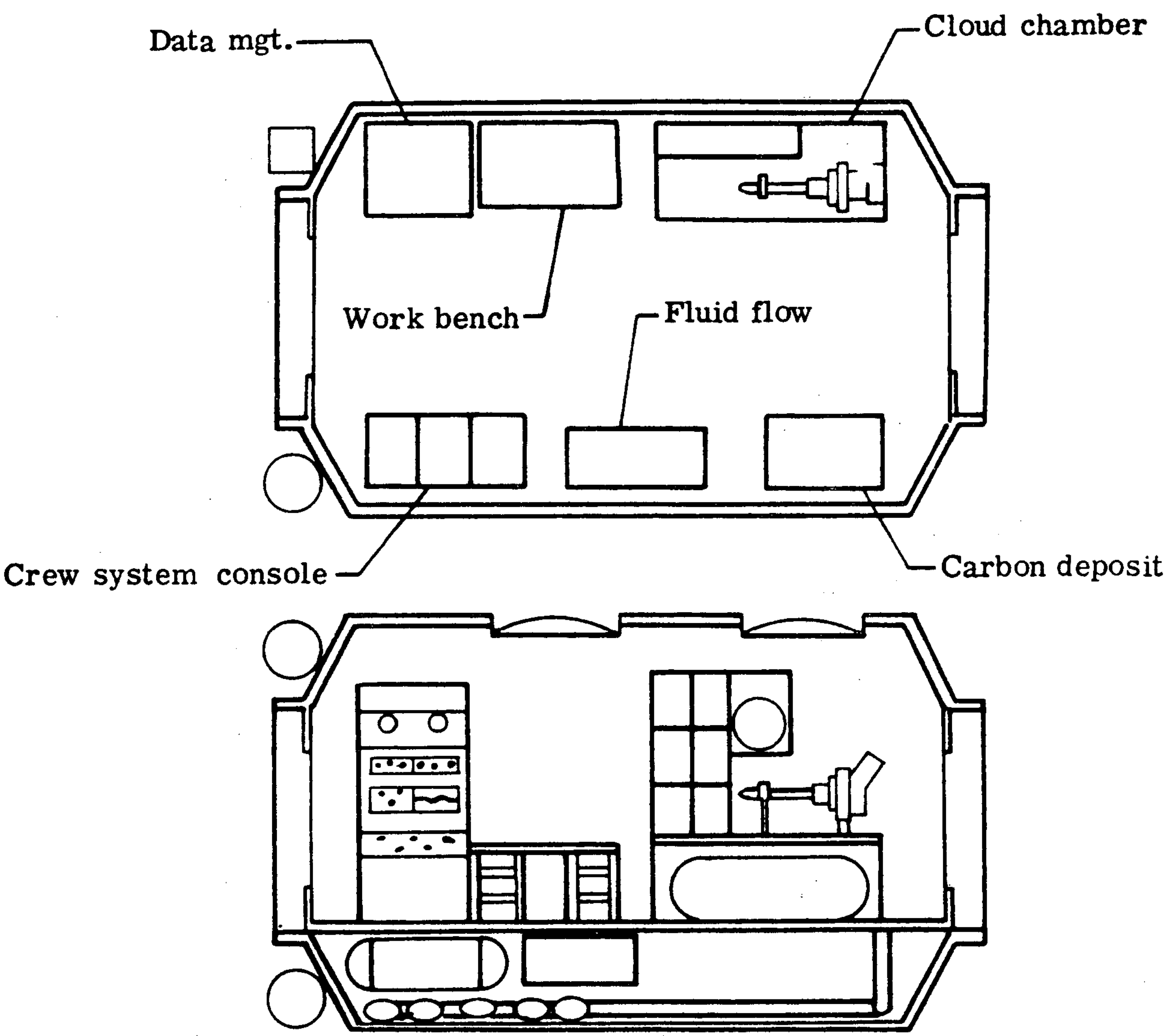
C

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			2,793	(6,157)
Docking		(200)		
Module Structure	1,873	(4,129)		
Environ. Protection	466	(1,028)		
Rack	363	(800)		
Environmental Control			143	(315)
Atmos & Thermal Cont.	113	(250)		
Life Support	30	(65)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			374	(825)
Data Mgmt.	95	(210)		
Communications	123	(270)		
Displays & Control	157	(345)		
Electrical			259	(570)
Conversion / Conditioning / Distribution	123	(270)		
Checkout	9	(20)		
Wiring	127	(280)		
Mission Equipment			2,683	(5,914)
Contamination Meas.	161	(354)		
Short Term Cryogenics	1,170	(2,580)		
Slush Propellant	649	(1,430)		
Non-cryogenics	522	(1,150)		
Bio-Research Module	181	(400)		
Total Weight			6,251	(13,781)
			6,251	
Crew Equipment, 113 kg (250 lb), and Residuals, 131 kg (288 lb)			244	(538)
Launch Weight			495	(14,319)

Comments: Module weight based on RAM payload module with airlock, see Ref. 10. Mission equipment data from Ref. 29.



Sortie RAM/Pallet Orbital Configuration



Typical ATL Zero Gravity Experiments

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PAYLOAD DATA SHEET

TITLE: Space Station - RAM Technology and Material Science Laboratory

AGENCY: NASA/OAST

CODE: NT2-64

PROGRAM: Space Technology & Material Science

COGNIZANT ENGINEER: D. Novik

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Orbiting laboratory for technology, physics, chemistry, material science, and manufacturing research*

Spacecraft Description: Large module attached to space station

Perigee km (n mi)/Apogee km (n mi)/Inclination deg:

500 (270) / 500 (270) / 55°

Launch Window: Rendezvous

Initial Launch Date: 1985 yr No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: _____ %

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 8,670 kg (19,113 lb)

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 9.8 m (32.0 ft) (vol) 139.5 m^3 (4,926.0 ft^3)

General Comments: * This data sheet will be limited to materials and manufacturing

MISSION EQUIPMENT Code NT2-64

Weight: 2,430 kg (5,356 lb) Power: 2 kW

Type of Experiment(s): Exploratory research and develop processes using space environment

Purpose of Experiment(s): To expand our knowledge of physical and chemical processes in materials, and to provide new processes

Type of Sensor(s): Environmental chamber, furnace, plasma ejection beam, TV camera, process control computer, material analysis equipment

Unique Sensor Requirements and Technology Status:

Environmental Requirements: 10^{-4} g

Data Processing and Transmission Requirements: 10 kbps and TV (10 Mbps)

Attitude Control and Pointing Accuracy Requirements: None

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NT2-64

Unique Structural Requirements: Manned module, endo

Environmental Control Requirements: Long duration

Guidance and Navigation Requirements: Space station

Propulsive Requirements: None

Type Propellant: ______ Thrust: ______

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: None

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: S-band

Antennas: Space station

Computers: ______ Commands: ______

Type of Electrical Power System: Space Station

Average Power: 2 kW Peak Power: 50 kW

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NT2-64

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch ____ Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: 6

Payload per Visit: ____ kg (____ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

Expected Maintenance Philosophy: On-orbit maintenance and ground refurbishment

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Retrieve module for refurbishment

WEIGHTS

Code NT2-64

Subsystem	Weights kg	(lb)	kg	(lb)
Structures			3,490	(7,695)
Module Structure	2,107	(4,644)		
Environ. Protection	1,103	(2,431)		
Docking	281	(620)		
Environmental Control			470	(1,035)
Atmos & Thermal Cont	333	(735)		
Life Support	136	(300)		
Guidance, Navigation, Stabilization			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Explusion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			39	(85)
Data Mgmt	25	(55)		
Communications	14	(30)		
Electrical			2,242	(4,942)
Power	1,253	(2,762)		
Conversion / Conditioning	544	(1,200)		
Distribution				
Checkout	9	(20)		
Wiring	435	(960)		
Mission Equipment			2,430	(5,356)
Experiments	2,052	(4,524)		
Integration	239	(526)		
Expendables	139	(306)		
Total Weight - Dry			8,531	(18,807)
Total Weight - Including Expendables			8,670	(19,113)
Crew Equipment, 61 kg (135 lb), and Residuals, 340 kg (748 lb)			401	(883)
Launch Weight			9,071	(19,996)

Comments: Weight based on Ref. 10

XI. Space Stations

PAYLOAD DATA SHEET

TITLE: Station Module - Crew Operations

AGENCY: NASA/OMSF

CODE: NS2-65

PROGRAM: Space Station

COGNIZANT ENGINEER: R. F. Lovelett

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Provide for habitability for six crewmen and control center for the space station

Spacecraft Description: Cylindrical with docking mechanism at each end and three radial docking ports located with 120 deg spacing

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55^{o}

Launch Window: NA days

Initial Launch Date: 1984 yr

No. of Satellites in System: 1 module for initial station

System Expected Lifetime: 6 yr as part of initial space station, thereafter as part of growth space station

Satellite Mean Mission Duration: NA yr

Satellite Desired Availability: Continuous

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 9,072 kg (20,000 lb)*

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 13.7 m (45.0 ft) (vol) 196.2 m^3 (6,927.2 ft^3)

General Comments: Module is docked to Power/Subsystems module 1 month after start of initial space station buildup; internal arrangement uses a 0-gravity longitudinal configuration; there are 3 private crew quarters and a complete hygiene facility at each end of the module.

* 7,044 kg (15,529 lb) plus 2,028 kg (4,471 lb) discretionary margin

See Ref. 31

MISSION EQUIPMENT Code NS2-65

Weight: 3,461 kg (7,631 lb) Power: NA W

Type of Experiment(s): NA

Purpose of Experiment(s): NA

Type of Sensor(s): 3 S-band antennas for communications; 3 external TV cameras

Unique Sensor Requirements and Technology Status: None

Environmental Requirements: Suitable for human occupancy at sea-level pressure over an indefinite period

Data Processing and Transmission Requirements: 118 k 32-bit words main memory; 500 k 32-bit words aux. memory; 6.6 x 10^{10} 32-bit word data accumulation per day

Attitude Control and Pointing Accuracy Requirements: Determined by NS2-67 GPL requirements

Propulsion Requirements: Crew/Operations Logistics module contributes propulsion for orbit adjustments and CMG desaturation

 Code NS2-65

Unique Structural Requirements: Radiation shielding and meteoroid bumper; docking mechanism at each end, 3 on sides

Environmental Control Requirements: Habitable environment, with sea-level atmospheric pressure, for indefinite period

Guidance and Navigation Requirements: Provided by Shuttle during station buildup

Propulsive Requirements: Orbit-keeping and CMG desaturation - low thrust; docking and maneuvers - high thrust (with Power/Subsystems module)

Type Propellant: Resistojets: CO_2 Thrusters: N_2H_4 Thrust: Resistojets: 0.10 N (0.025 lb) Thrusters: 110 N (25 lb)

Orbit Adjust: Resistojet Total Impulse: Periodically replenished

Apogee Kick Motor: NA

Attitude Control: CMG with resistojet desaturation

Pointing Accuracy: See GPL requirements Pointing Direction: Depends upon station pointing, which varies

Tracking, Telemetry and Command Requirements: Communications duties shared with Power/Subsystems module

Antennas: 3, 2.4 m (8.0 ft) diam, high gain dish, K_u-S-band

Computers: Control console for station computer Commands: NA

Type of Electrical Power System: 115 Vdc into module, converted to ac

Average Power: Peak Power:

Unique Interstage/Adapter Requirements: None

SHUTTLE INTERFACE Code NS2-65

Compatibility with Other Spacecraft in Shuttle: Yes NA No NA

Access to Spacecraft in Shuttle Required: Prelaunch No Post Launch No

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other Data management

Visits:

No. of Visits per Year: None, except for visits of Logistics modules and RAMS

Payload per Visit: 6,350 kg (14,000 lb) in Logistics module

Purpose of Visit: Refurbish X Replace X (Refurbish and maintain module, replace consumables and RAMS)

Maintain X

Stay Time Required: 30 days for Logistics modules

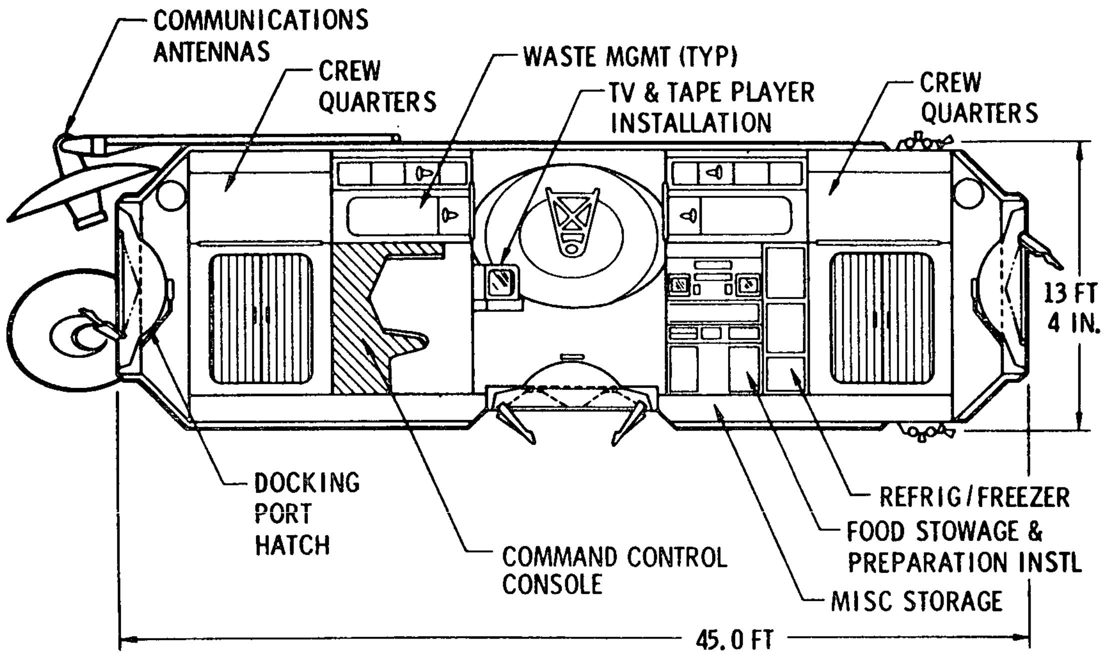
Requirement for Retrieval: Yes X No ____ Desirable ____

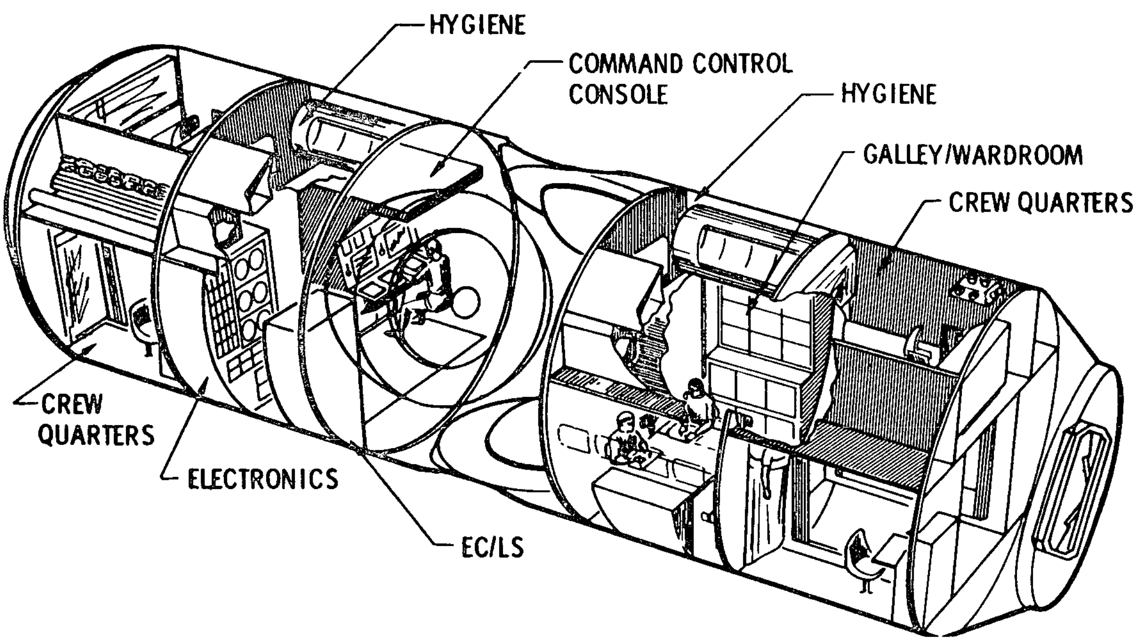
Expected Maintenance Philosophy: Will be repaired in orbit by the station's crew

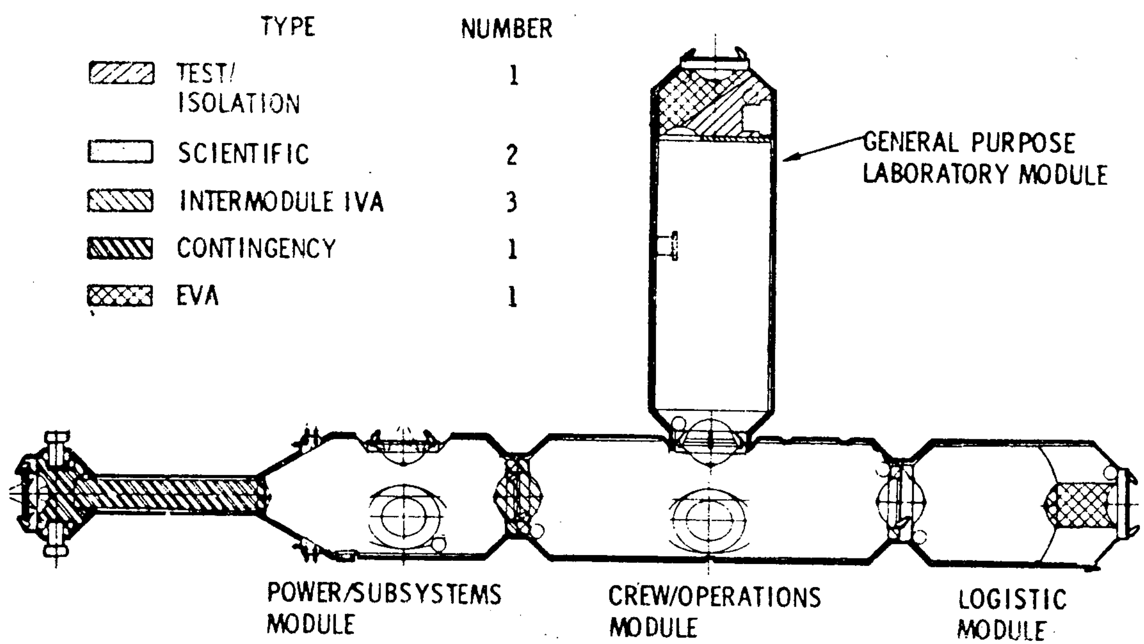
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle greatly simplifies the problems of module rendezvous and docking during station buildup. Return of the Crew/Operations Logistics module to the ground for overhaul, major repair, or replacement would not be possible without the Shuttle.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			3,460	(7,627)
Basic Structure	1,838	(4,052)		
Meteoroid & Thermal Protection		(2,036)		
Docking Provisions	698	(1,539)		
Environmental Control			938	(2,068)
Atmos & Thermal Cont	608	(1,340)		
Residuals & Reserves	330	(728)		
Guidance, Navigation, Stabilization			147	(323)
Propulsion			178	(392)
Attitude Control (Mass Explusion)			25	(56)
Telemetry, Tracking, Command			366	(807)
Electrical			497	(1,096)
Batteries } Conversion }	7	(15)		
Conditioning	130	(287)		
Distribution	360	(794)		
Mission Equipment			3,461	(7,631)
Crew Life Support & Interiors	1,138	(2,509)		
Crew Equipment	606	(1,337)		
Discretionary Payload	1,717	(3,785)		
Total Weight			9,072	(20,000)
Adapter			0	(0)
Launch Weight			9,072	(20,000)

Comments: Weight data from Ref. 31


COMMUNICATIONS ANTENNAS
CREW QUARTERS
WASTE MGMT (TYP)
TV & TAPE PLAYER INSTALLATION
CREW QUARTERS
13 FT 4 IN.
DOCKING PORT HATCH
COMMAND CONTROL CONSOLE
REFRIG/FREEZER
FOOD STOWAGE & PREPARATION INSTL
MISC STORAGE
45.0 FT


HYGIENE
COMMAND CONTROL CONSOLE
HYGIENE
GALLEY/WARDROOM
CREW QUARTERS
CREW QUARTERS
ELECTRONICS
EC/LS



Integrated Space Station Airlock Summary

PAYLOAD DATA SHEET

TITLE: Station Module - Power/Sub-systems

AGENCY: NASA/OMSF

CODE: NS2-66

PROGRAM: Space Station

COGNIZANT ENGINEER: R. F. Lovelett

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Provides source of electrical power for entire station; 406° K (270°F) H_2O for silica bed/mal sieve desorption, urine H_2O recovery, H_2O heating, H_2O pasteurization; elements of many subsystems including GNC, communications, propulsion (tanks and thrusters), and DMS (computer)

Spacecraft Description: Cylindrical with a boom at one end; in orbit, large solar array is deployed in four large, flat sheets from the boom

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55°

Launch Window: Rendezvous and docking

Initial Launch Date: 1984 yr

No. of Satellites in System: 1 module for initial station

System Expected Lifetime: 6 yr as part of initial space station, thereafter as part of growth space station

Satellite Mean Mission Duration: NA

Satellite Desired Availability: Continuous

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 9,072 kg (20,000 lb)*

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 17.7 m (58.0 ft) (vol) 252.8 m^3 (8,928.4 ft^3)

General Comments: This is first module launched in buildup of initial space station; it contains all subsystems necessary to sustain the station cluster until assembly is completed and manning and regular logistics resupply are initiated 3 months later.

* 7,944 kg (17,513 lb) plus 1,128 kg (2,487 lb) discretionary margin

See Ref. 31

MISSION EQUIPMENT   Code NS2-66

Weight: NA kg (______ lb)   Power: ______ W

Type of Experiment(s): None

Purpose of Experiment(s): NA

Type of Sensor(s): S-band and VHF antennas for communication; star tracker, star sensor, and horizon sensor for attitude control

Unique Sensor Requirements and Technology Status: None

Environmental Requirements: Part of module must be suitable for human occupancy at sea-level pressure over an indefinite period

Data Processing and Transmission Requirements: Contains station computer central process unit, main memory, command units, other digital storage; transmission via Crew/Operations Logistics module

Attitude Control and Pointing Accuracy Requirements: Determined by GPL requirements; see GPL data

Propulsion Requirements: Power/subsystems module, as part of the station, contributes propulsion for orbit adjustments and CMG desaturation

SUPPORTING SUBSYSTEMS Code NS2-66

Unique Structural Requirements: Radiation shielding and meteoroid bumper; docking mechanism on end, 3 on sides

Environmental Control Requirements: Part of module provides a habitable environment with sea-level atmosphere pressure; rest of module can be pressurized

Guidance and Navigation Requirements:

Propulsive Requirements: Orbit-keeping and CMG desaturation - low thrust; docking and maneuvers - high thrust (with Crew/Operations Logistics module)

Type Propellant: Resistojets: CO_2 Thrusters: N_2H_4 Thrust: Resistojets: 0.10 N (0.025 lb) Thrusters: 110 N (25 lb)

Orbit Adjust: Resistojet Total Impulse: Periodically replenished

Apogee Kick Motor: NA

Attitude Control: Control moment gyros, desaturated by thrusters

Pointing Accuracy: See GPL requirements Pointing Direction: Depends upon station pointing, which varies

Tracking, Telemetry and Command Requirements: Communications duties shared with Crew/Operations Logistics module

Antennas: 3 VHF, 3 S-band, low gain/omni/slot

Computers: Contains units of station computer Commands: NA

Type of Electrical Power System: Solar array, 492 m^2 (5,300 ft^2)

Average Power: 16.7 kW at 5 yr Peak Power: 22.7 kW at beginning of mission

Unique Interstage/Adapter Requirements: None

SHUTTLE INTERFACE Code NS2-66

Compatibility with Other Spacecraft in Shuttle: Yes ______ No ______

Access to Spacecraft in Shuttle Required: Prelaunch _____ Post Launch _____

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other Data management

Visits:

No. of Visits per Year: None (except Logistics modules and RAMS)

Payload per Visit: Up to 6,350 kg (14,000 lb) in Logistics modules

Purpose of Visit: Refurbish X Replace X Refurbish and maintain consumables and RAMS

Maintain X

Stay Time Required: 30 days for Logistics modules

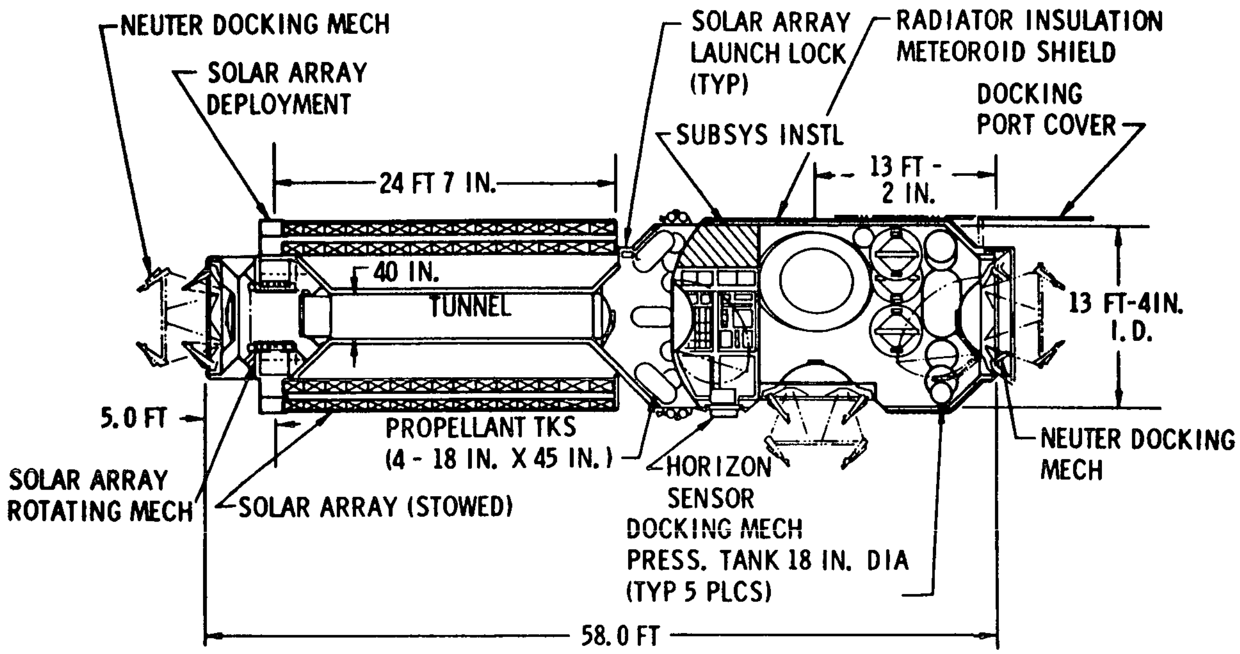
Requirement for Retrieval: Yes X No ______ Desirable ______

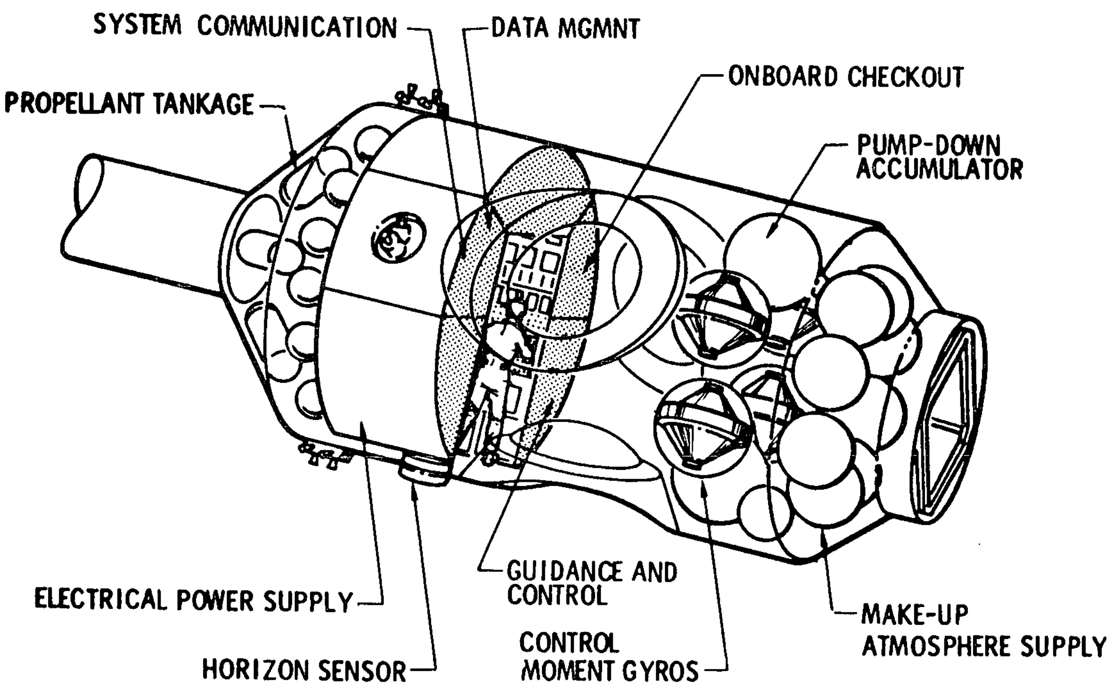
Expected Maintenance Philosophy: Module will be repaired in orbit by the station crew

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle greatly simplifies problems of module rendezvous and docking during station buildup. Return of the Power/Subsystems module to the ground for overhaul, major repair, or replacement would not be possible without the Shuttle.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			3,244	(7,152)
Basic Structure	1,590	(3,505)		
Meteoroid & Thermal Protection	956	(2,108)		
Docking Provisions	698	(1,539)		
Environmental Control			736	(1,622)
Atmos & Thermal Cont.	538	(1,185)		
Residuals & Reserves	198	(437)		
Guidance, Navigation, Stabilization			210	(463)
Propulsion			612	(1,350)
Attitude Control (Mass Expulsion)			101	(222)
Telemetry, Tracking, Command			139	(306)
Electrical			2,666	(5,878)
Batteries, Conversion	713	(1,571)		
Conditioning	305	(673)		
Distribution	263	(580)		
Solar Array	1,385	(3,054)		
Mission Equipment			1,364	(3,007)
Crew Life Support & Interiors	189	(416)		
Crew Equipment	227	(500)		
Discretionary Payload	949	(2,091)		
Total Weight - Dry			9,072	(20,000)
Adapter			0	(0)
Launch Weight			9,072	(20,000)

Comments: Weight data from Ref. 31


NEUTER DOCKING MECH
SOLAR ARRAY DEPLOYMENT
SOLAR ARRAY LAUNCH LOCK (TYP)
RADIATOR INSULATION METEOROID SHIELD
DOCKING PORT COVER
SUBSYS INSTL
24 FT 7 IN.
13 FT - 2 IN.
40 IN.
TUNNEL
13 FT-4IN. I.D.
5.0 FT
PROPELLANT TKS (4 - 18 IN. X 45 IN.)
HORIZON SENSOR
NEUTER DOCKING MECH
SOLAR ARRAY ROTATING MECH
SOLAR ARRAY (STOWED)
DOCKING MECH
PRESS. TANK 18 IN. DIA (TYP 5 PLCS)
58.0 FT


SYSTEM COMMUNICATION
DATA MGMNT
PROPELLANT TANKAGE
ONBOARD CHECKOUT
PUMP-DOWN ACCUMULATOR
GUIDANCE AND CONTROL
ELECTRICAL POWER SUPPLY
MAKE-UP ATMOSPHERE SUPPLY
CONTROL MOMENT GYROS
HORIZON SENSOR

PAYLOAD DATA SHEET

TITLE: Station Module - General Purpose Laboratory

AGENCY: NASA/OMSF

CODE: NS2-67

PROGRAM: Space Station

COGNIZANT ENGINEER: R. F. Lovelett

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Supports research and applications program. Contains seven facilities: (1) electrical/electronics lab, (2) mechanical sciences lab, (3) optical sciences lab, (4) biomedical and biological sciences lab, (5) hard data processing facility, (6) data evaluation facility, (7) isolation and test lab

Spacecraft Description: Cylindrical, with docking mechanism at each end; external surface is relatively free of protuberances; one airlock

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270)/500 (270)/ 55°.

Launch Window: Rendezvous and docking

Initial Launch Date: 1984 yr

No. of Satellites in System: 1 module for initial station

System Expected Lifetime: 10 yr as part of initial space station, thereafter as part of growth space station

Satellite Mean Mission Duration: NA yr

Satellite Desired Availability: Continuous

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 9,072 kg (20,000 lb)*

Satellite Launch Dimensions: (diam) 4.3 m (14 ft) (length) 13.7 m (45 ft) (vol) 196.2 m^3 (6,927.2 ft^3)

General Comments: This is the third and last module launched to build up the initial space station. It is radially docked to the Crew/Operations Logistics module. No radial docking ports are located in the GPL. It contains one large and one small airlock for experiments and EVA activities.

*7,070 kg (15,587 lb) plus 2,002 kg (4,413 lb) discretionary margin

See Ref. 31

MISSION EQUIPMENT   Code NS2-67

Weight: 3,783 kg (8,339 lb) Power: Varies

Type of Experiment(s): Supports experiments of varying description, both within itself and within RAMS joined to or near the station

Purpose of Experiment(s): Various

Type of Sensor(s): Various

Unique Sensor Requirements and Technology Status: Various

Environmental Requirements: Environment must be suitable for human occupancy at sea-level pressure over an indefinite period. Special environments for experiments available in RAMS and two scientific airlocks.

Data Processing and Transmission Requirements: Contains film processors (color and b & w), printer, microfilm retrieval system, copy machine, video tape unit, microfilmer

Attitude Control and Pointing Accuracy Requirements: $\pm$ 0.02 deg in earth-oriented mode, $\pm$ 0.05 deg in inertial mode; $\pm$ 0.001 deg/sec

Propulsion Requirements: Propulsion is provided by the Shuttle (during station buildup) and by other modules during orbital operations

SUPPORTING SUBSYSTEMS Code NS2-67

Unique Structural Requirements: Radiation shielding and meteoroid bumper; docking mechanism at each end, small airlock on side

Environmental Control Requirements: Habitable environment, sea-level atmospheric pressure, for indefinite period

Guidance and Navigation Requirements: Provided by Shuttle during station buildup and by Crew/Operations Logistics module thereafter

Propulsive Requirements: None, except for propulsion provided by Shuttle during buildup and propulsion provided by station

Type Propellant: NA **Thrust:** NA

Orbit Adjust: NA **Total Impulse:** NA **kg-sec** (**lb-sec)**

Apogee Kick Motor: NA

Attitude Control: CMG with resistojet desaturation

Pointing Accuracy: See prev. pg. **Pointing Direction:** Earth, inertial, sun, gravity gradient, etc.

Tracking, Telemetry and Command Requirements: None; all station telemetry handled by Crew/Operations Logistics module

Antennas: None

Computers: Computation capability located in Crew/Operations Logistics module **Commands:** NA

Type of Electrical Power System: 115 Vdc into GPL, converted to ac

Average Power: 4.8 kW **Peak Power:**

Unique Interstage/Adapter Requirements: None

SHUTTLE INTERFACE Code NS2-67

Compatibility with Other Spacecraft in Shuttle: Yes ______ No ______

Access to Spacecraft in Shuttle Required: Prelaunch No Post Launch No

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other Data management

Visits:

No. of Visits per Year: None (except Logistics modules docking with Crew/ Operations Logistics module)

Payload per Visit: Up to 6,350 kg (14,000 lb) in Logistics module

Purpose of Visit: Refurbish X Replace X Refurbish and maintain module, replace consumables and RAMS

Maintain X

Stay Time Required: 30 days for Logistics modules

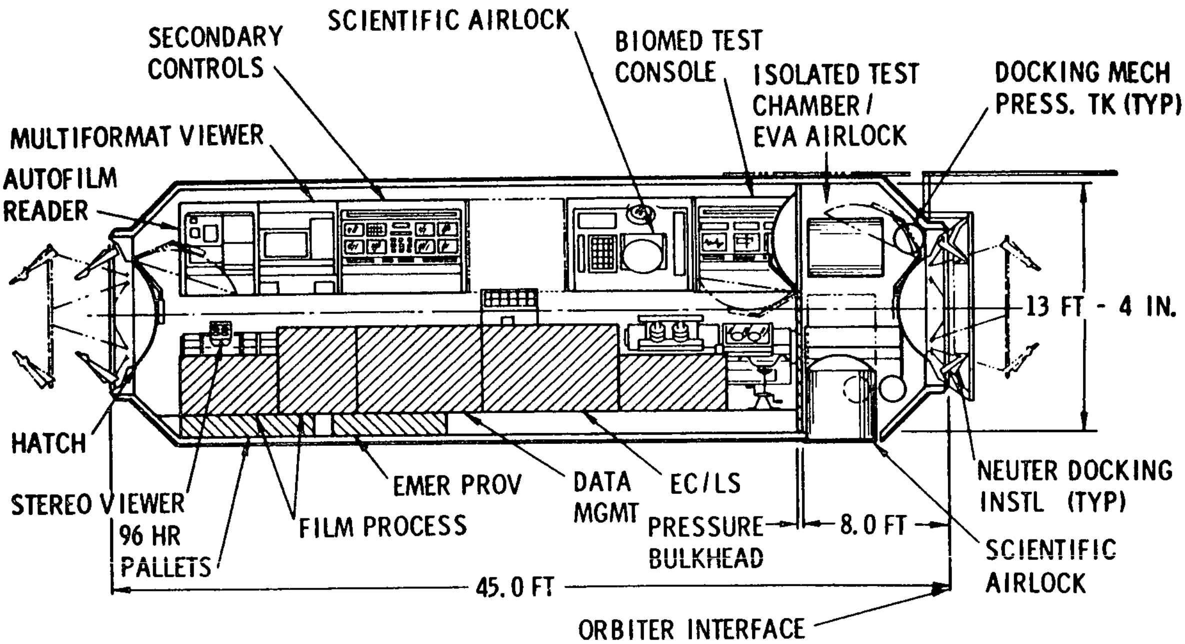
Requirement for Retrieval: Yes X No ______ Desirable ______

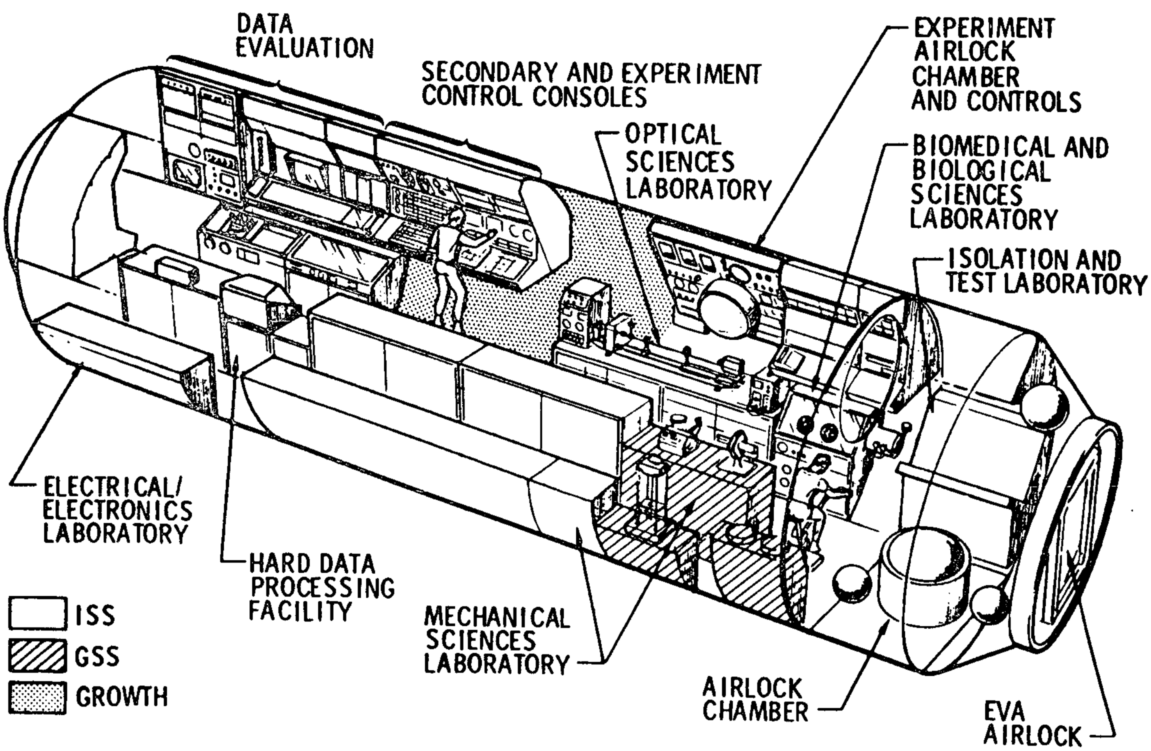
Expected Maintenance Philosophy: Will be repaired in orbit by the station's crew

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Shuttle greatly simplifies the problems of module rendezvous and docking during station buildup. Return of the GPL to the ground for overhaul, major repair, or replacement would not be possible without the Shuttle.

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			3,252	(7,170)
Basic Structure	2,065	(4,553)		
Meteoroid & Thermal Protection	908	(2,002)		
Docking Provisions	279	(615)		
Environmental Control			1,022	(2,254)
Atmosphere & Thermal Control	692	(1,526)		
Residuals & Reserves	330	(728)		
Guidance, Navigation, Stabilization			286	(631)
Propulsion			47	(104)
Telemetry, Tracking, Command			49	(109)
Electrical			632	(1,393)
Batteries, Conversion	7	(15)		
Conditioning	157	(346)		
Distribution	468	(1,032)		
Mission Equipment			3,783	(8,339)
Crew Life Support & Interiors	310	683		
Crew Equipment	600	(1,323)		
Discretionary Payload	1,006	(2,217)		
GPL & Experiment Provisions	1,867	(4,116)		
Total Weight -			9,072	(20,000)
Adapter				
Launch Weight			9,072	(20,000)

Comments: Weight data from Ref. 31.


SECONDARY CONTROLS
SCIENTIFIC AIRLOCK
BIOMED TEST CONSOLE
ISOLATED TEST CHAMBER / EVA AIRLOCK
DOCKING MECH PRESS. TK (TYP)
MULTIFORMAT VIEWER
AUTOFILM READER
13 FT - 4 IN.
HATCH
STEREO VIEWER
96 HR PALLETS
FILM PROCESS
EMER PROV
DATA MGMT
EC/LS
PRESSURE BULKHEAD
8.0 FT
NEUTER DOCKING INSTL (TYP)
SCIENTIFIC AIRLOCK
45.0 FT
ORBITER INTERFACE


DATA EVALUATION
SECONDARY AND EXPERIMENT CONTROL CONSOLES
EXPERIMENT AIRLOCK CHAMBER AND CONTROLS
OPTICAL SCIENCES LABORATORY
BIOMEDICAL AND BIOLOGICAL SCIENCES LABORATORY
ISOLATION AND TEST LABORATORY
ELECTRICAL/ ELECTRONICS LABORATORY
HARD DATA PROCESSING FACILITY
MECHANICAL SCIENCES LABORATORY
AIRLOCK CHAMBER
EVA AIRLOCK
ISS
GSS
GROWTH

PAYLOAD DATA SHEET

TITLE: Crew/Operations Logistics Module

AGENCY: NASA/OMSF

CODE: NS2-68

PROGRAM: Space Station

COGNIZANT ENGINEER: R. F. Lovelett

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Carries 6,350 kg (14,000 lb) cargo to the initial space station. Stays attached to station during resupply interval, serving as reservoir for consumables to be used on demand, providing safe volume for refuge and contingency volume for crew isolation and extra accommodations. Stores trash and hard copy data and experiment equipment for return to earth.

Spacecraft Description: Short cylinder with docking mechanism at each end. The external surface is free of protuberances such as thrusters and antennas.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 500 (270) / 500 (270) / 55°

Launch Window: Rendezvous and dock with station

Initial Launch Date: 1985 yr

No. of Satellites in System: 1 module always at station

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: NA yr

Satellite Desired Availability: Continuous

Characteristic Velocity: 7,978 m/sec (26,174 ft/sec)

Satellite Weight: 9,072 kg (20,000 lb)*

Satellite Launch Dimensions: (diam) 4.3 m (14.0 ft) (length) 8.5 m (28.0 ft) (vol) 122.1 m^3 (4,310.3 ft^3)

General Comments: Pressurized compartment is arranged into three functional spaces: (1) palletized (solid) cargo, (2) liquid/gas cargo, and (3) special cargo. Egress/ingress from Shuttle requires pressurized transfer tunnel which is also used as two-man EVA airlock for station operations.

* 8,006 kg (17,650 lb) plus 1,066 kg (2,350 lb) discretionary margin

See Ref. 31

MISSION EQUIPMENT

Code NS2-68

Weight: NA kg (lb) Power: NA W

Type of Experiment(s): None

Purpose of Experiment(s): NA

Type of Sensor(s): None

Unique Sensor Requirements and Technology Status: NA

Environmental Requirements: Pressurized volume must be habitable by man over extended periods, with atmospheric pressure equal to sea level (although Logistics module is generally uninhabited)

Data Processing and Transmission Requirements: None

Attitude Control and Pointing Accuracy Requirements: None; supplied by Shuttle

Propulsion Requirements: None; supplied by Shuttle

SUPPORTING SUBSYSTEMS Code NS2-68

Unique Structural Requirements: Module has pressurized volume of 75 m^3 (2,630 ft^3) and unpressurized volume of 16.4 m^3 (580 ft^3)

Environmental Control Requirements: Habitable environment, sea-level atmospheric pressure

Guidance and Navigation Requirements: Provided by Shuttle

Propulsive Requirements: Provided by Shuttle

Type Propellant: NA Thrust: NA

Orbit Adjust: NA Total Impulse: NA kg-sec (lb-sec)

Apogee Kick Motor: NA

Attitude Control: Provided by Shuttle and station

Pointing Accuracy: See GPL reqmts Pointing Direction: Depends upon station pointing, which varies

Tracking, Telemetry and Command Requirements: None

Antennas: None

Computers: None Commands: NA

Type of Electrical Power System: Obtains power from Shuttle or station

Average Power: Peak Power: 308 W

Unique Interstage/Adapter Requirements: None

SHUTTLE INTERFACE Code NS2-68

Compatibility with Other Spacecraft in Shuttle: Yes ______ No ______

Access to Spacecraft in Shuttle Required: Prelaunch No Post Launch Yes

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other Data management

Visits:

No. of Visits per Year: Average 4 per year

Payload per Visit: Up to 6,350 kg (14,000 lb)

Purpose of Visit: Refurbish X Replace X Refurbish and maintain station, replace station parts, consumables, crew

Maintain X

Stay Time Required: 30 days

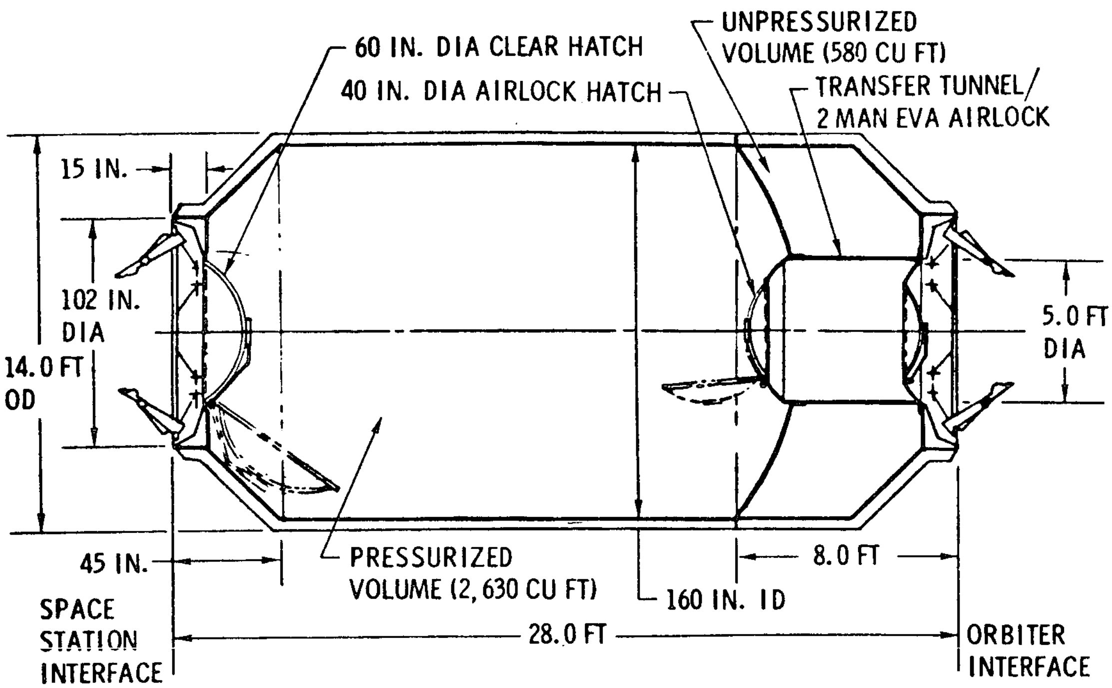
Requirement for Retrieval: Yes X No ______ Desirable ______

Expected Maintenance Philosophy: Will be repaired and refurbished on the ground wherever possible

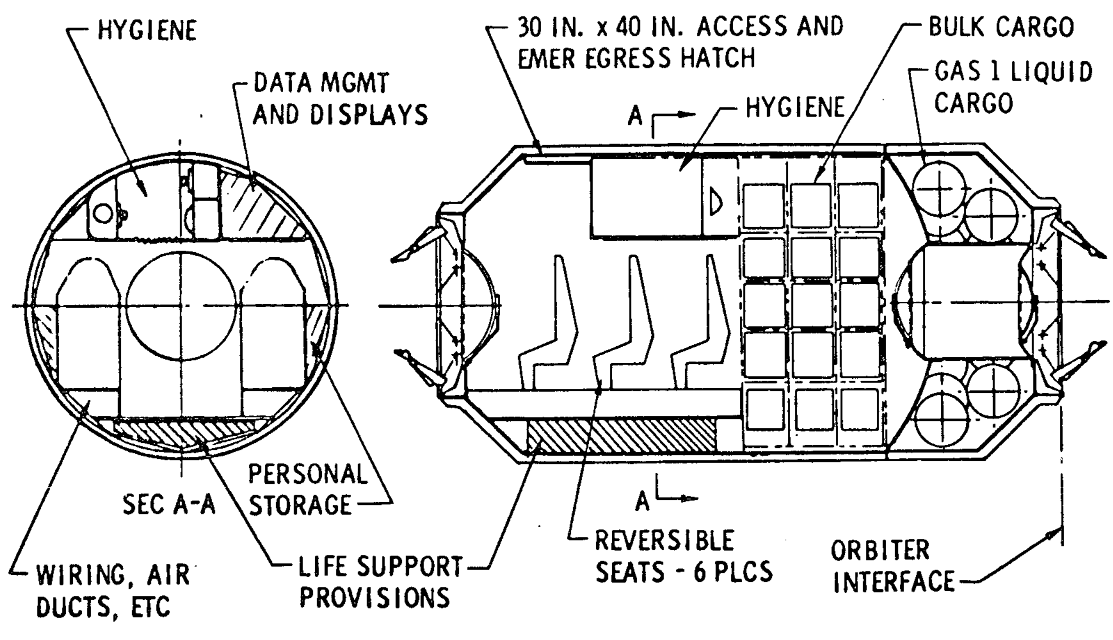
General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: The Logistics module would have to incorporate a reentry (atmospheric) capability if expendable launch vehicle used; would be less practical; payload capability would be reduced

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			1,979	(4,363)
Basic Structure	1,199	(2,643)		
Meteoroid & Thermal Protection	501	(1,104)		
Docking Provisions	279	(616)		
Environmental Control			181	(400)
Atmosphere & Thermal Control	73	(160)		
Residuals & Reserves	109	(240)		
Guidance, Navigation, Stabilization			207	(456)
Propulsion			75	(166)
Electrical			110	(242)
Batteries, Conversion	---	---		
Conditioning	35	(77)		
Distribution	75	(165)		
Mission Equipment			6,520	(14,373)
Crew Life Support & Interiors	197	(435)		
Crew Equipment	---	---		
Discretionary Payload	1,066	(2,350)		
Cargo	5,256	(11,588)		
Total Weight			9,072	(20,000)
Adapter				
Launch Weight			9,072	(20,000)

Comments: Weight data from Ref. 31



Logistics Module - Inboard Profile



Logistics Module Conversion to Crew/Cargo Module

XII. Lunar Exploration

PAYLOAD DATA SHEET

TITLE: Lunar Landing Tug (LLT) AGENCY: NASA/OMSF

CODE: NLU-1

PROGRAM: Lunar Exploration COGNIZANT ENGINEER: S. DiMaggio

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Fly crew and cargo from orbiting lunar station (OLS) or lunar orbit to anywhere on the lunar surface; transport logistic payload to lunar surface; provide transportation between any cislunar vehicle, OLS, LSB; also used as a Space Tug sortie for lunar rescue operations and mini-base operations.

Spacecraft Description: Similar to Space Tug plus landing gear and crew module

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Lunar altitude of 111 km (60 nmi) to lunar surface

Launch Window: NA days

Initial Launch Date: 1987 yr No. of Satellites in System: NA

System Expected Lifetime: 3 yr (reusable at least 10 times)

Satellite Mean Mission Duration: 1 yr

Satellite Desired Availability: Emergency - Rescue - Escape

Characteristic Velocity: 4,308 m/sec (14,133 ft/sec)*

Satellite Weight: 39,091 kg (86,180 lb)**

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 14.3 m (47.0 ft) (vol) 235.0 m^3*** (8,300 ft^3)

General Comments: * ΔV down = 2,243 m/sec (7,360 ft/sec); ΔV up = 2,064 m/sec (6,773 ft/sec)

** Launch weight: 11,793 kg (26,000 lb) burnout

*** Dimensions without payload or crew module

MISSION EQUIPMENT Code NLU-1

Weight: * kg (lb) Power: 2.35 kW

Type of Experiment(s): Transport cargo; 993 kg (2,190 lb) of experiments, including 113 kg (250 lb) of sample return

Purpose of Experiment(s):

Type of Sensor(s): Video, thermal, chemical, and biological sensors

Unique Sensor Requirements and Technology Status: Automatic or manual control system for rendezvous, docking, and landing

Environmental Requirements: Micrometeoroid protection; airlock for crew egress and ingress

Data Processing and Transmission Requirements: Voice link, TM, video, and command and control; downlink data rate ~10^7 Hz, uplink data rate ~10^5 Hz

Attitude Control and Pointing Accuracy Requirements: $\pm$ 5 deg coast

Propulsion Requirements: 27,216 kg (60,000 lb) of LO_2/LH_2

* Round-trip payload weight = 9,072 kg (20,000 lb); one-way expended = 22,680 kg (50,000 lb)

SUPPORTING SUBSYSTEMS Code NLU-1

Unique Structural Requirements: Neuter docking sidearms for cargo deployment, endo type structure

Environmental Control Requirements: Passive/active system; crew life support

Guidance and Navigation Requirements:

Propulsive Requirements: 925 kg (2,040 lb) for attitude control

Type Propellant: H_2/O_2 Thrust: 20 thrusters - 890 N (200 lb) thrust each

Orbit Adjust: No Total Impulse: * kg-sec (lb-sec)

Apogee Kick Motor: Yes

Attitude Control: 3-axis; 4-pentad cluster; 91 kg (200 lb) thrust

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: USB for ranging, command; voice and telemetry on USB and possibly UHF; RF output 40-47 dbm

Antennas: 3 to 4, 0.15 to 3 m (0.5 to 10 ft), omni/low gain/high gain, S-band and X-band

Computers: Nav and attitude control Commands: 256-512 (64 bits) real time and stored

Type of Electrical Power System: Fuel cells or primary batteries

Average Power: Peak Power:

Unique Interstage/Adapter Requirements:

* Rendezvous, 1.37 m/sec (4.5 ft/sec); lunar operations, 135 m/sec (444 ft/sec)

SHUTTLE INTERFACE Code NLU-1

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical ___

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: NA

Payload per Visit: ___ kg (___ lb)

Purpose of Visit: Refurbish X Replace X

Maintain X Operate ___

Stay Time Required: ___ hr

Requirement for Retrieval: Yes X No ___ Desirable ___

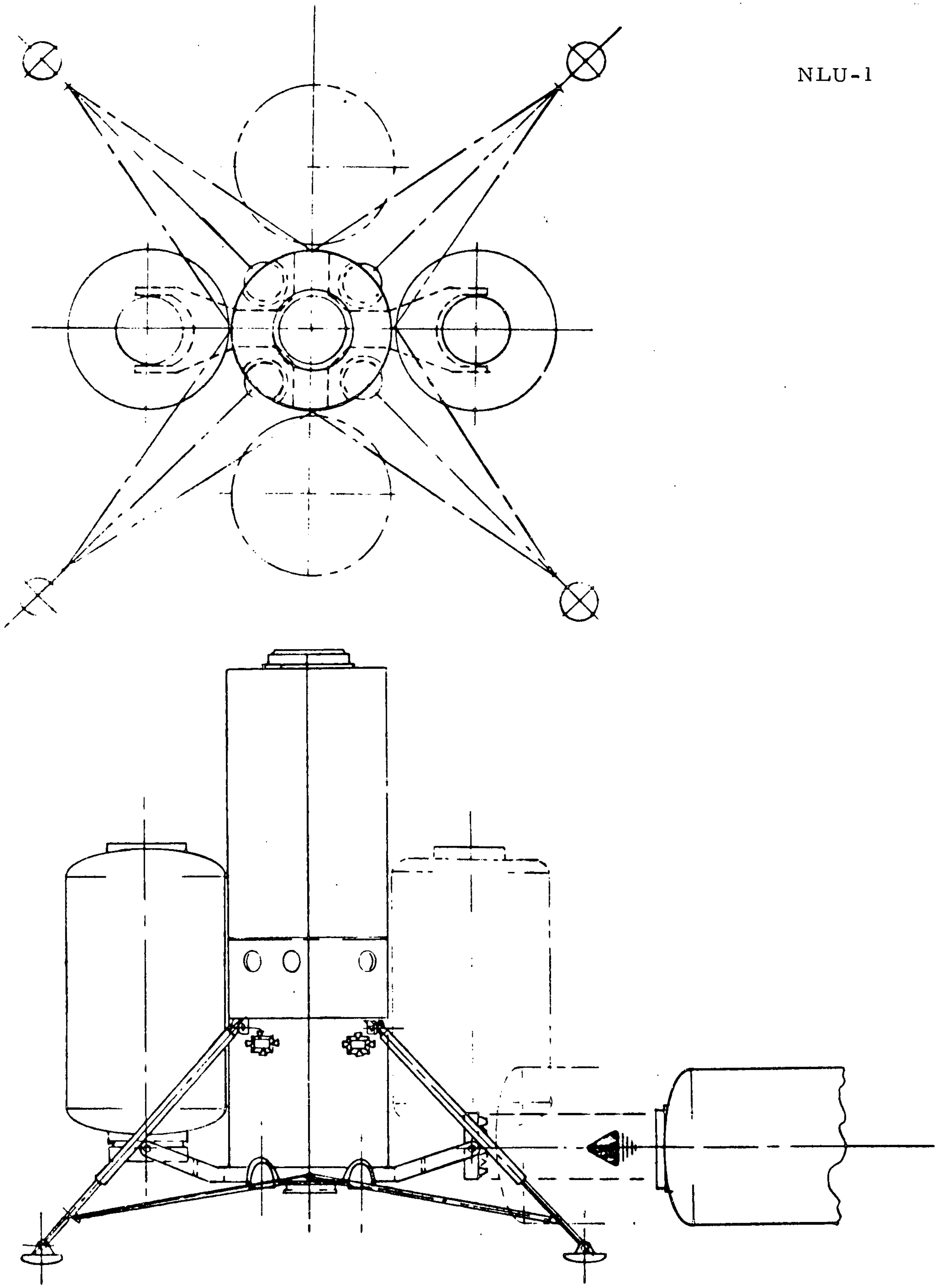
Expected Maintenance Philosophy: Module replacement on LSB or on OLS.

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

The Lunar Landing Tug is space-based and therefore extends the operational capability of the Shuttle.

Subsystem	Weights kg	lb	kg	lb
Structures, Mechanisms, Vehicle Assembly			3,116	(6,870)
Tanks, Meteoroid Shield	1,234	(2,720)		
Landing Gear	1,497	(3,300)		
Thrust Str., Docking, Misc.	186	(410)		
Inst. Unit Struct.	200	(440)		
Environmental Control - Insulation			352	(775)
Guidance, Navigation, Stabilization			54	(120)
Propulsion			27,946	(61,610)
Engine and Gimbal Actuation	524	(1,155)		
Propellant Delivery, Fill, Vent Drain	109	(240)		
Propellant Utilization	45	(100)		
Pressurization	52	(115)		
Propellant	27,216	(60,000)		
Attitude Control (Mass Expulsion)			594	(1,310)
Propellant (O_2/H_2)	422	(930)		
Subsystem Dry	172	(380)		
Telemetry, Tracking, Command			386	(850)
Electrical			236	(520)
Crew and Crew Provisions			6,407	(14,125)
Crew of 4 men	363	(800)		
Crew Support Provisions*	1,644	(3,625)		
Crew Module	4,101	(9,040)		
Others	299	(660)		
Total Weight - Including Expendables			39,091	(86,180)

* Provisions for 4 men for 28-day surface sortie, plus 14-day contingency, plus 347 kg (765 lb) for PLSSs and suits for 4 additional crew



Baseline Space Tug as Configured for LSB (See Ref. 32)

PAYLOAD DATA SHEET

TITLE: Cargo Module AGENCY: NASA/OMSF

CODE: NLU-2

PROGRAM: Lunar Exploration COGNIZANT ENGINEER: S. DiMaggio

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Provide logistics for science and consumables from lunar orbit to lunar surface

Spacecraft Description: Cargo consists of geoscience equipment, geoscience return cargo, consumables, and module structure

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Lunar altitude 111 km (60 nmi) / polar orbit

Launch Window: ________ days

Initial Launch Date: 1987 yr No. of Satellites in System: ________

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: NA yr

Satellite Desired Availability: As scheduled

Characteristic Velocity: NA m/sec (NA ft/sec)

Cargo Weight: 22,680 kg (50,000 lb) one way; 9,072 kg (20,000 lb) round trip

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 4.6 m (15.0 ft) (vol) 76 m^3 2,690 ft^3

General Comments: Initial flights will consist of 22,680 kg (50,000 lb) of cargo; must be compatible with Cislunar Shuttle, Space Shuttle, Orbiting Lunar Station (OLS), Lunar Surface Base (LSB), and Lunar Landing Tug (LLT)

See Ref. 32

MISSION EQUIPMENT Code NLU-2

Weight: N/A kg (N/A lb) Power: NA W

Type of Experiment(s): Geoscience; X-ray telescope, optical and radio telescopes, antennas, transponders; labs; drill

Purpose of Experiment(s):

Type of Sensor(s):

Unique Sensor Requirements and Technology Status:

Environmental Requirements:

Data Processing and Transmission Requirements:

Attitude Control and Pointing Accuracy Requirements:

Propulsion Requirements:

SUPPORTING SUBSYSTEMS Code NLU-2

Unique Structural Requirements: Docking provisions and cargo easily transferable

Environmental Control Requirements: Passive/active system

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: NA Thrust: NA

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: None

Pointing Accuracy: NA Pointing Direction: NA

Tracking, Telemetry and Command Requirements: None

Antennas: NA

Computers: ______ Commands: ______

Type of Electrical Power System: None

Average Power: ______ Peak Power: ______

Unique Interstage/Adapter Requirements: Docking provisions

SHUTTLE INTERFACE Code NLU-2

Compatibility with Other Spacecraft in Shuttle: Yes X No ____

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical X

Environment X

Checkout X

Other ____

Visits:

No. of Visits per Year: As scheduled

Payload per Visit: 9,072 - 22,680 kg (20,000 - 50,000 lb)

Purpose of Visit: Refurbish ____ Replace X

Maintain X Operate X

Stay Time Required: ____ hr

Requirement for Retrieval: Yes X No ____ Desirable ____

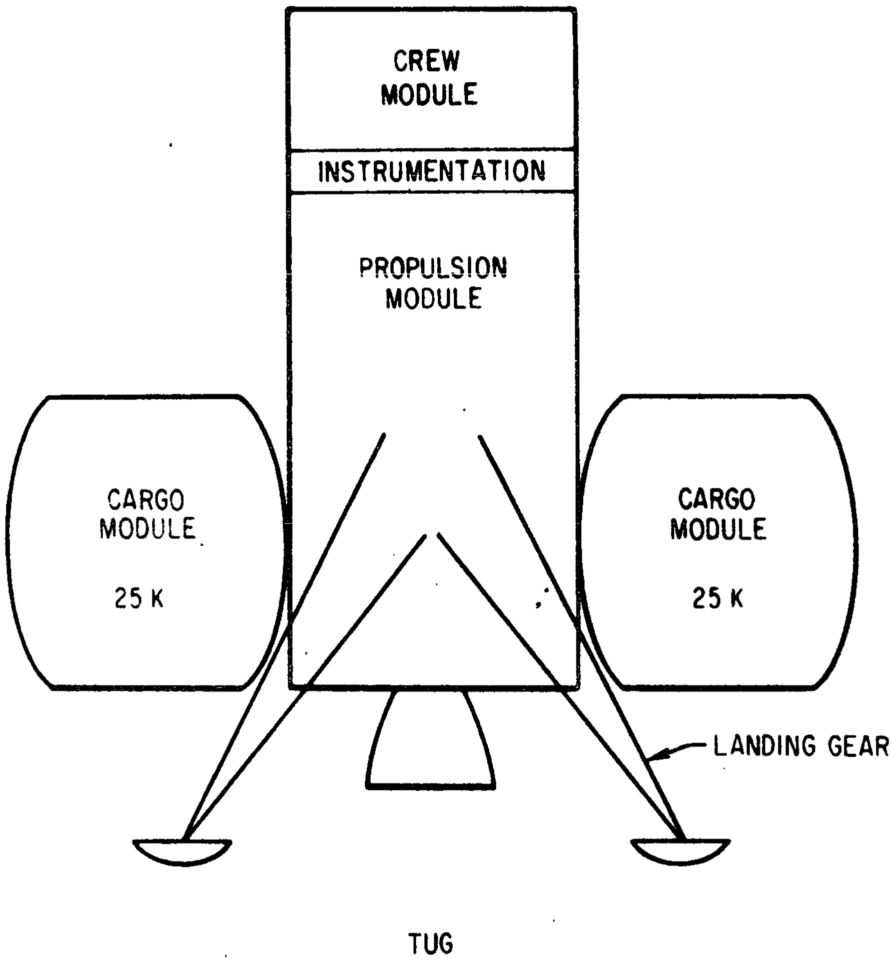
Expected Maintenance Philosophy: Preventive maintenance if capability is available

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ____

Code NLU-2

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			3,856	(8,500)
Environmental Control			680	(1,500)
Guidance, Navigation, Stabilization				
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)				
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command				
Electrical				
Batteries				
Conversion				
Conditioning				
Distribution				
Cargo			18,144	(40,000)
Total Weight			22,680	(50,000)
Adapter				
Launch Weight				

Comments: Payload is function of mission and may vary from 4,536 to 22,680 kg (10,000 to 50,000 lb).



LUNAR SPACE TUG LANDER
WITH TWO CARGO MODULES ATTACHED

PAYLOAD DATA SHEET

TITLE: Crew Rotation Module

AGENCY: NASA/OMSF

CODE: NLU-3

PROGRAM: Lunar Exploration

COGNIZANT ENGINEER: S. DiMaggio

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Crew module to rotate principal investigator and crewmen between lunar orbit and lunar surface; to perform lunar scientific sorties (4 men - 28-day duration plus 14-day contingency)

Spacecraft Description: Crew quarters for a nominal crew size of 4 and up to a maximum of 12 for rescue

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: 111 (60) / 111 (60) / polar, lunar orbit

Launch Window: ______ days

Initial Launch Date: 1987 yr

No. of Satellites in System: ______

System Expected Lifetime: 3 yr

Satellite Mean Mission Duration: NA yr

Satellite Desired Availability: As scheduled

Characteristic Velocity: NA m/sec (NA ft/sec)

Satellite Weight: 4,600 kg (10,140 lb)

Satellite Launch Dimensions: (diam) 4.6 m (15.0 ft) (length) 4.6 m (15.0 ft) (vol) 76 m^3 (2,690 ft^3)

General Comments: Must be compatible with any Cislunar Shuttle, OLS, Lunar Tug, LSB, and Space Shuttle.

MISSION EQUIPMENT Code NLU-3

Weight: N/A kg (N/A lb) Power: ______ W

Type of Experiment(s): ______

Purpose of Experiment(s): ______

Type of Sensor(s): Video, thermal, chemical, and biological sensors

Unique Sensor Requirements and Technology Status: ______

Environmental Requirements: Solar flare, micrometeoroid, and radiation

Data Processing and Transmission Requirements: Voice, video, and commands; downlink data rate $\sim 10^7$ Hz; uplink data rate $\sim 10^5$ Hz

Attitude Control and Pointing Accuracy Requirements: NA

Propulsion Requirements: NA

SUPPORTING SUBSYSTEMS Code NLU-3

Unique Structural Requirements: Air lock for crew ingress and egress; secondary latch for redundancy

Environmental Control Requirements: Passive/active; crew life support

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: NA Thrust: NA

Orbit Adjust: ______ Total Impulse: ______ kg-sec (______ lb-sec)

Apogee Kick Motor: ______

Attitude Control: ______

Pointing Accuracy: ______ Pointing Direction: ______

Tracking, Telemetry and Command Requirements: Downlink rate 10^7 Hz; uplink $\sim 10^5$ Hz; RF output 40-43 dbm

Antennas: 3 to 4, 0.15 to 3 m (0.5 to 10.0 ft), omni/high gain, S-band and X-band

Computers: Navigation/Control Commands: 256-512 (64 bits) real time and stored

Type of Electrical Power System: Fuel cells or batteries

Average Power: ______ Peak Power: ______

Unique Interstage/Adapter Requirements: ______

SHUTTLE INTERFACE Code NLU-3

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch X

Support Requirement on Shuttle During Transportation:

Electrical ___

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: As scheduled

Payload per Visit: 4 crew; 12 in emergency

Purpose of Visit: Recycle crew and principal investigator; return lunar samples and equipment

Stay Time Required: 45 days

Requirement for Retrieval: Yes X No ___ Desirable ___

Expected Maintenance Philosophy: Maintenance, repair, and reuse

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: Maximum use as Lunar Science Sortie and crew rotation from lunar surface

WEIGHTS

Code NLU-3

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms			1,247	(2,750)
Environmental Control			671	(1,480)
Guidance, Navigation, Stabilization			358	(790)
Propulsion Propellant Subsystem Dry			0	(0)
Attitude Control (Mass Expulsion) Propellant Subsystem Dry			227	(500)
Telemetry, Tracking, Command			181	(400)
Electrical Batteries Conversion Conditioning Distribution			304	(670)
Crew Equipment			1,610	(3,550)
Crew, Furnish (4 men)	522	(1,150)		
Life Supp. (water, food, atmos. - 30 days)	748	(1,650)		
Furnishings for 8 additional crew for emerg.	340	(750)		
Total Weight - Excluding life support			3,851	(8,490)
Total Weight - Including Expendables			4,600	(10,140)
Adapter			159	(350)
Launch Weight			4,759	(10,490)

Comments: ______________________________

PAYLOAD DATA SHEET

TITLE: Orbiting Lunar Station AGENCY: NASA/OMSF

CODE: NLU-4

PROGRAM: Lunar Exploration COGNIZANT ENGINEER: S. DiMaggio

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Orbital science laboratory to study moon surface environment, conduct moon mapping, support LSB pre-activities, support the LSB logistically when fully activated, and provide safety and rescue haven.

Spacecraft Description: 8 to 12-man crew for 109 days as orbital science laboratory; 3 years conducting 4-man sortie missions to surface every 108 days for 28-day stay; establish lunar base and continue multi-site sortie missions; maximum quiescent capability 1 year, 20 men - rescue requirements.

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: Lunar altitude - 111 km (60 nmi), lunar inclination - polar

Launch Window: ______ days

Initial Launch Date: 1988 yr No. of Satellites in System: 1

System Expected Lifetime: 10 yr

Satellite Mean Mission Duration: 10 yr

Satellite Desired Availability: NA %

Characteristic Velocity: NA m/sec (NA ft/sec)

Satellite Weight: 101,112 kg (222,909 lb)

Satellite Launch Dimensions: (diam) 4.3 m (length) 12.8 m*(vol) 183.1 m^3

(14.0 ft) (42.0 ft)* (6,465.4 ft^3)

General Comments: Must be compatible with Lunar Tug, Cislunar Shuttle, and Space Shuttle; OLS is modularized.

* Most of the modules are 9.8 m (32.0 ft) in length.

See Ref. 33

MISSION EQUIPMENT Code NLU-4

Weight: N/A kg (N/A lb) Power: ______ W

Type of Experiment(s): See attachment for further description

Purpose of Experiment(s): Lunar mapping and site location for Lunar Base

Type of Sensor(s): Electromagnetic, particle sensors, field sensors, and high resolution cameras; video, thermal, chemical, and biological sensors

Unique Sensor Requirements and Technology Status: ______

Environmental Requirements: Meteoroid and solar flares

Data Processing and Transmission Requirements: Data rate 10^5 - 10^7 Hz (voice, video, command)

Attitude Control and Pointing Accuracy Requirements: Pointing accuracy 0.05 deg/sec stability; point direction - 0.25 deg attitude

Propulsion Requirements: ______

SUPPORTING SUBSYSTEMS Code NLU-4

Unique Structural Requirements: Modularized with 11 modules; in-space assembly

Environmental Control Requirements: Active system, closed CO_2 and H_2O loop; radiation protection shelter included; thermal and meteoroid protection

Guidance and Navigation Requirements: RES and CMG; include landmark trackers, radar altimeter, horizon and star trackers

Propulsive Requirements: Attitude control and orbit adjust with H_2O_2 propulsion system controlled by inertial reference

Type Propellant: H_2O_2 Thrust: 110 N (25 lb)

Orbit Adjust: Yes Total Impulse: 1.02×10^7 N-sec (2,296,000 lb-sec)

Apogee Kick Motor: No

Attitude Control: 3-axis inertia wheels, CMG

Pointing Accuracy: 0.05 deg/sec stability Pointing Direction: Moon and earth

Tracking, Telemetry and Command Requirements: Downlink rate 10^5 - 10^7 Hz on 2/3 links; command and ranging via USB

Antennas: 8 directive, 8 semi-directive; 1 spherical, 1.5 m (5 ft) diam, 4 - 1.5 x 4.3 m (5 x 14 ft), 3 - 1.5 x 1.8 m (5 x 6 ft), 8 - 1.8 m (6 ft) diam x 2.4 m (8 ft) parabolas; phased arrays and parabolic reflectors; S-and X-band

Computers: Centralized and dedicated Commands: 256-512 (64 bits) real time and stored

Type of Electrical Power System: 929 m^2 (10,000 ft^2) solar array with regenerative fuel cells

Average Power: 20 kW Peak Power: 22.8 kW

Unique Interstage/Adapter Requirements:

SHUTTLE INTERFACE Code NLU-4

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical ___

Environment X

Checkout X

Other ___

Visits:

No. of Visits per Year: 4

Payload per Visit: 2,087 kg (4,600 lb)/month

Purpose of Visit: Refurbish ___ Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: Modular spare part replacement

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle:

Logistic resupply enhanced with Space Shuttle and considerably more cost effective.

Derivative OLS Weight Summary

Step	Items	Lunar Orbit Modular Space Station	
1	Core Module 1A	31,685	
	Core Module Dry Weight		29,395
	Core Module Consumables		2,290
2	Core Module 1B	25,295	
	Core Module Dry Weight		23,005
	Core Module Consumables		2,290
3	Power Module	24,215	
	Power Module Dry Weight		17,313
	Power Module Consumables		6,902
4	Cryo Module 1	10,058	
	Cryo Module Dry Weight		7,689
	Cryo Module Consumables		2,369
5	Cryo Module 2	26,721	
	Cryo Module Dry Weight		10,545
	Cryo Module Consumables		16,176
6	Control Center Module 1	36,600	
	Control Center Module Dry Weight		18,290
	Control Center Module Consumables		2,310
	Water - Radiation Shelter		16,000
7	Control Center Module 2	11,720	
	Control Center Module Dry Weight		11,340
	Control Center Module Consumables		380
8	Crew Quarters Module 1	15,325	
	Crew Quarters Module Dry Weight		13,840
	Crew Quarters Module Consumables		1,485
9	Crew Quarters Module 3	12,915	
	Crew Quarters Module Dry Weight		12,365
	Crew Quarters Consumables		550
10	Galley Module	15,775	
	Galley Module Dry Weight		10,781
	Galley Module Consumables		4,994
11	Experiment Module	11,000	
	Experiment Module Dry Weight		11,000
	Experiment Module Consumables		0
	Crew 8-man	1,600	
	Derivative OLS Gross Weight 101,112 kg	(222,909) lb	

WEIGHTS (CORE 1A) **Code** NLU-4

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			4,699	(10,360)
Basic	3,529	(7,780)		
Docking Prov.	1,170	(2,580)		
Environmental Control			2,096	(4,620)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			16	(35)
Propulsion				-
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			1,084	(2,390)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			556	(1,225)
Electrical, Pyrotechnics			4,332	(9,550)
Prime Power	3,740	(8,245)		
Conversion				
Conditioning	592	(1,305)		
Distribution				
Mission Equipment			551	(1,215)
Crew accommodations				
Personal equipment	531	(1,170)		
Displays, Controls	20	(45)		
Experiments		-		
Supt. Equip		-		
Expendables (O_2, H_2)			1,039	(2,290)
Total Weight - Dry			13,334	(29,395)
Total Weight - Including Expendables			14,373	(31,685)
Adapter			---	---
Launch Weight			14,373	(31,685)

Comments: Assume 8 man station

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			4,831	(10,650)
Basic	3,529	(7,780)		
Docking Prov.	1,302	(2,870)		
Environmental Control			2,096	(4,620)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			864	(1,905)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			1,084	(2,390)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			107	(235)
Electrical, Pyrotechnics			1,311	(2,890)
Prime Power	923	(2,035)		
Conversion				
Conditioning	388	(855)		
Distribution				
Mission Equipment			143	(315)
Crew accommodations		-		
Personal equipment	123	(270)		
Displays, Controls	20	(45)		
Expendables (O_2, N_2)			1,039	(2,290)
Total Weight - Dry			10,435	(23,005)
Total Weight - Including Expendables			11,475	(25,295)
Adapter			---	---
Launch Weight			11,475	(25,295)

Comments: Assume 8 man station

WEIGHTS (POWER MODULE) **Code** NLU-4

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			1,545	(3,405)
Basic	1,241	(2,735)		
Docking Prov.	304	(670)		
Environmental Control			642	(1,415)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			0	(0)
Propulsion				-
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			293	(645)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			269	(593)
Electrical, Pyrotechnics			4,999	(11,020)
Prime Power	4,683	(10,325)		
Conversion				
Conditioning	315	(695)		
Distribution				
Mission Equipment			61	(135)
Crew accommodations	-	-		
Personal equipment	61	(135)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Expendables (Cryo)			3,131	(6,902)
Total Weight - Dry			7,808	(17,213)
Total Weight - Including Expendables			10,939	(24,115)
Adapter			---	---
Launch Weight			10,939	(24,115)

Comments: Assume 8 man station

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			1,960	(4,320)
Basic	1,597	(3,520)		
Docking Prov.	363	(800)		
Environmental Control			566	(1,247)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			16	(35)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			759	(1,674)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			35	(78)
Electrical, Pyrotechnics			93	(205)
Prime Power	54	(120)		
Conversion	39	(85)		
Conditioning				
Distribution				
Mission Equipment			59	(130)
Crew accommodations	-	-		
Personal equipment	59	(130)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Expendables (Cryo)			1,165	(2,569)
Total Weight - Dry			3,488	(7,689)
Total Weight - Including Expendables			4,653	(10,258)
Adapter				
Launch Weight			4,653	(10,258)

Comments: Assume 8 man station

WEIGHTS (CRYO MODULE 2) Code NLU-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			1,960	(4,320)
Basic	1,597	(3,520)		
Docking Prov.	363	(800)		
Environmental Control			566	(1,247)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			16	(35)
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			2,082	(4,590)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			8	(18)
Electrical, Pyrotechnics			93	(205)
Prime Power	54	(120)		
Conversion	39	(85)		
Conditioning				
Distribution				
Mission Equipment			59	(130)
Crew accommodations	-	-		
Personal equipment	59	(130)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Expendables			7,335	(16,171)
Total Weight - Dry			4,783	(10,545)
Total Weight - Including Expendables			12,118	(26,716)
Adapter				
Launch Weight			12,118	(26,716)

Comments: Assume 8 man station

WEIGHTS (CONTROL CENTER MODULE 1) Code NLU-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			4,529	(9,985)
Basic	1,812	(3,995)		
Docking Prov.	395	(870)		
Experiment Labs	2,322	(5,120)		
Environmental Control			9,536	(21,022)
Thermal	917	(2,022)		
	8,618	(19,000)		
Guid., Navig., Stabiliz.			0	(0)
Propulsion			-	-
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			-	-
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			897	(1,978)
Electrical, Pyrotechnics			454	(1,000)
Prime Power		-		
Conversion				
Conditioning	454	(1,000)		
Distribution				
Mission Equipment			138	(305)
Crew accommodations	-	-		
Personal equipment	138	(305)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Expendables			1,048	(2,310)
Total Weight - Dry			15,554	(34,290)
Total Weight - Including Expendables			16,602	(36,600)
Adapter				
Launch Weight			16,602	(36,600)

Comments: Assume 8 man station

WEIGHTS (CONTROL CENTER MODULE 2) Code NLU-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			2,118	(4,670)
Basic	1,724	(3,800)		
Docking Prov.	395	(870)		
Environmental Control			1,392	(3,068)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			1,008	(2,222)
Electrical, Pyrotechnics			454	(1,000)
Prime Power		-		
Conversion		-		
Conditioning	454	(1,000)		
Distribution		-		
Mission Equipment			172	(380)
Crew accommodations		-		
Personal equipment	172	(380)		
Displays, Controls		-		
Experiments		-		
Supt. Equip		-		
Expendables			172	(380)
Total Weight - Dry			5,144	(11,340)
Total Weight - Including Expendables			5,316	(11,720)
Adapter				
Launch Weight			5,316	(11,720)

Comments: Assume 8 man station

WEIGHTS (CREW QUARTERS MODULE 1) Code NLU-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			2,146	(4,730)
Basic	1,751	(3,860)		
Docking Prov.	395	(870)		
Environmental Control			3,005	(6,625)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			293	(645)
Electrical, Pyrotechnics			454	(1,000)
Prime Power		-		
Conversion				
Conditioning	454	(1,000)		
Distribution				
Mission Equipment			381	(840)
Crew accommodations	-	-		
Personal equipment	361	(795)		
Displays, Controls	20	(45)		
Experiments	-	-		
Supt. Equip	-	-		
Expendables			674	(1,485)
Total Weight - Dry			6,278	(13,840)
Total Weight - Including Expendables			6,952	(15,325)
Adapter				
Launch Weight			6,952	(15,325)

Comments: Assume 8 man station

WEIGHTS (CREW QUARTERS MODULE 3) Code NLU-4

Subsystem	Weights kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			2,146	(4,730)
Basic	1,751	(3,860)		
Docking Prov.	395	(870)		
Environmental Control			2,520	(5,555)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			152	(335)
Electrical, Pyrotechnics			454	(1,000)
Prime Power				
Conversion				
Conditioning	454	(1,000)		
Distribution				
Mission Equipment			338	(745)
Crew accommodations	-	-		
Personal equipment	338	(745)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Expendables			249	(550)
Total Weight - Dry			5,609	(12,365)
Total Weight - Including Expendables			5,858	(12,915)
Adapter				
Launch Weight			5,858	(12,915)

Comments: Assume 8 man station

WEIGHTS (GALLEY MODULE) Code NLU-4

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			2,186	(4,820)
Basic	1,792	(3,950)		
Docking Prov.	395	(870)		
Environmental Control			1,677	(3,696)
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.			0	(0)
Propulsion			0	(0)
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)			0	(0)
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command			143	(315)
Electrical, Pyrotechnics			454	(1,000)
Prime Power		-		
Conversion				
Conditioning	454	(1,000)		
Distribution				
Mission Equipment			431	(950)
Crew accommodations	-	-		
Personal equipment	431	(950)		
Displays, Controls	-	-		
Experiments	-	-		
Supt. Equip	-	-		
Food			1,656	(3,650)
Expendables			610	(1,344)
Total Weight - Dry			4,890	(10,781)
Total Weight - Including Expendables			7,156	(15,775)
Adapter				
Launch Weight			7,156	(15,775)

Comments: Assume 8 man station

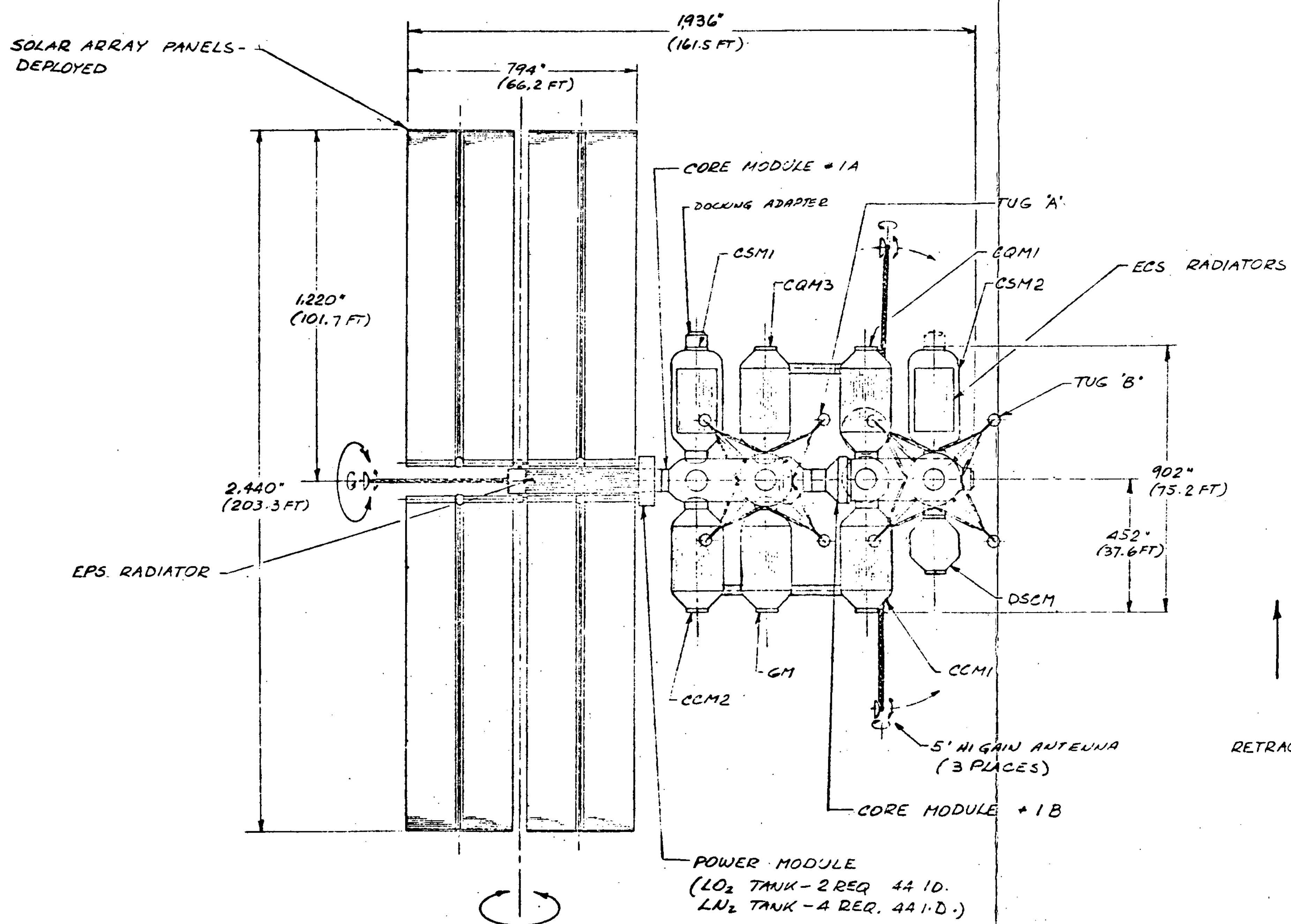
WEIGHTS (EXPERIMENT MODULE) Code NLU-4

Subsystem	Weights			
	kg	(lb)	kg	(lb)
Structures, Mechanisms, Vehicle Assembly			4,990	(11,000)
Basic				
Docking Prov.				
Environmental Control				
Thermal				
Meteoroid				
Guid., Navig., Stabiliz.				
Propulsion				
Propellant				
Subsystem Dry				
Attitude Control (Mass Expulsion)				
Propellant				
Subsystem Dry				
Telemetry, Tracking, Command				
Electrical, Pyrotechnics				
Prime Power				
Conversion				
Conditioning				
Distribution				
Mission Equipment				
Crew accommodations				
Personal equipment				
Displays, Controls				
Total Weight - Dry			4,990	(11,000)
Total Weight - Including Expendables			4,990	(11,000)
Adapter				
Launch Weight			4,990	(11,000)

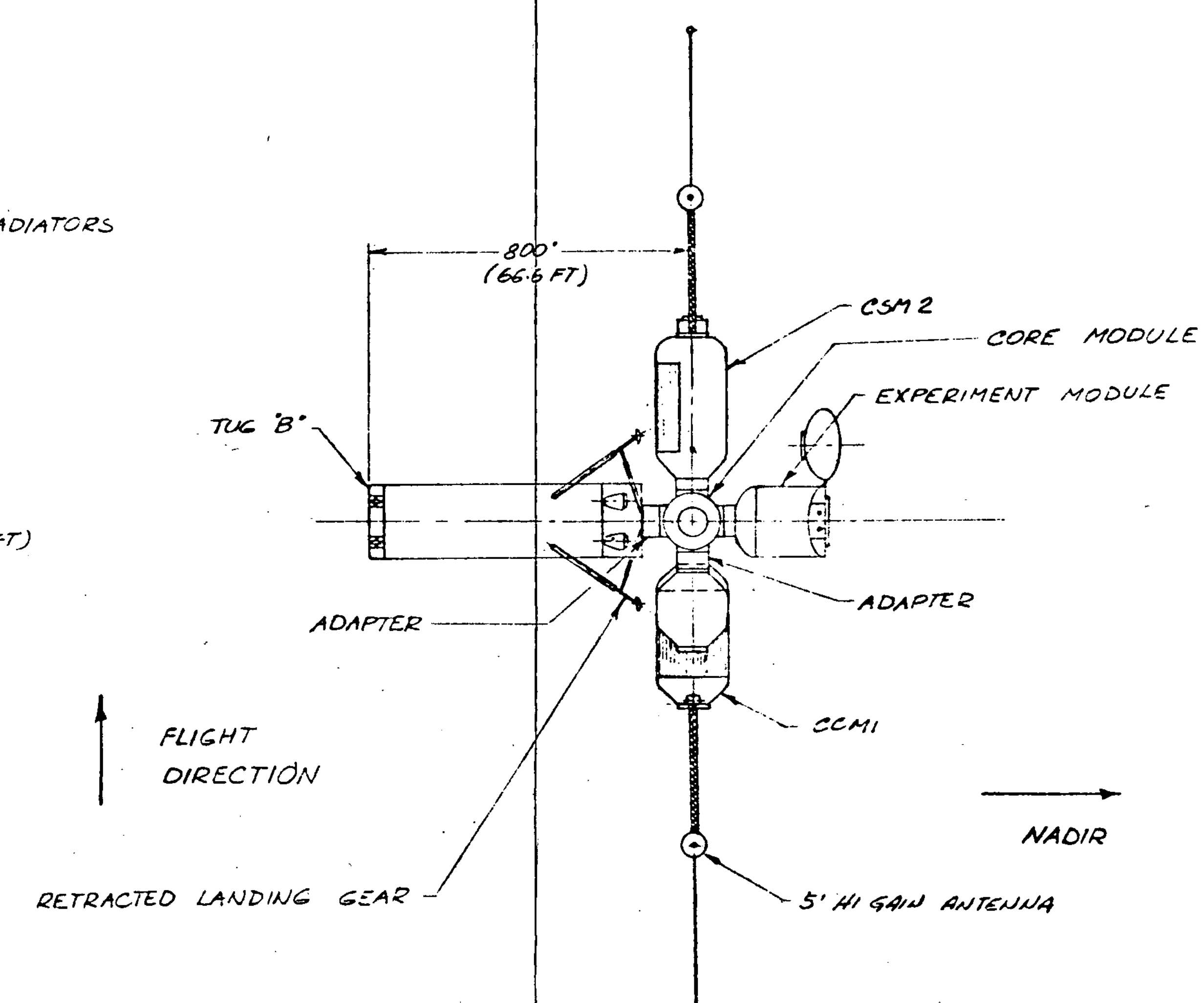
Comments: Assume 8 man station

FOLDOUT FRAME 1

FOLDOUT FRAME 2



DERIVATIVE OLS FLIGHT CONFIGURATION



Summary of Scientific Objectives Supported by Orbital Experiments

Subobjectives		Orbital Experiment	
AY-6	Resolve radio and optical observations of solar system sources	5027	Radio interference from earth
GG-1 through GG-8	All geology and geochemistry subobjectives	5002	Orbital geological mapping and analysis
GG-2	Determine physical, mineralogical, and chemical properties of lunar materials	5006	Petrographic and mineralogic identification and analysis
		5017	Remote geochemical analysis
GG-8	Locate geologically favorable sites for advanced lunar exploration/exploitation scientific facilities	5016	High-resolution mapping of selected sites
GP-1	Determine lunar mass distribution	5020	Spacecraft orbital perturbations
		5028	Gravity gradient
GP-2	Determine physical state and composition of the lunar interior	5018	Electrical properties of lunar surface and subsurface
GP-3	Evaluate the lunar internal dynamics	5019	Thermal anomalies and surface structure
GP-4	Determine earth-moon mechanical interactions	5020	Spacecraft orbital perturbations
LA-1	Determine the total quantity and distribution of the component species of the lunar atmosphere	5024	Total pressure
		5025	Composition of lunar atmosphere
LA-2	Determine principal natural atmospheric source, loss, and transport mechanisms and their rates	5026	Escape and transport rates in lunar atmosphere
LA-3	Monitor atmospheric contamination resulting from lunar missions, including transport and escape rates	5024, 5025, and 5026	
PF-1	Evaluate solar wind-moon interaction	5021	Solar wind and energetic particles
		5023	Electric fields
PF-2	Evaluate fundamental physics of plasma interactions	5021, 5023	
PF-3	Determine magnetic and electric fields	5022	Magnetic fields
		5023	Electric fields
PF-4	Measure lunar particle environment	5021	Solar wind and energetic particles
GC-1	Establish a three-dimensional geodetic control system of the lunar surface	5013	Geodetic grid construction and topographic mapping
GC-2	Collect photogrammetric data and construct topographic maps	5013	Geodetic grid construction and topographic mapping

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PAYLOAD DATA SHEET

TITLE: Lunar Surface Base

AGENCY: NASA/OMSF

CODE: NLU-5

PROGRAM: Lunar Exploration

COGNIZANT ENGINEER: S. DiMaggio

COGNIZANT SCIENTIST:

MISSION OBJECTIVES: Semi-permanent lunar base preparatory to a permanent lunar base

Spacecraft Description: Provide crew quarters and lab facilities for 12 crewmen for 3 to 6 months rotation time

Perigee km (n mi)/Apogee km (n mi)/Inclination deg: NA

Launch Window: ______ days

Initial Launch Date: 1991 yr

No. of Satellites in System: 1

System Expected Lifetime: 5 yr

Satellite Mean Mission Duration: 5 yr

Satellite Desired Availability: NA %

Characteristic Velocity: NA m/sec (NA ft/sec)

Satellite Weight: 62,987* kg (138,860* lb)

Satellite Launch Dimensions:** (diam) 4.3 m (14.0 ft) (length) 9.1 m (30.0 ft) (vol) 131 m^3 (4,618 ft^3)

General Comments: *38,327 kg (84,495 lb) basic shelter + 24,660 kg (54,365 lb) science equipment = 62,987 kg (138,860 lb) total

**each of 9 modules

See Ref. 32, 34

MISSION EQUIPMENT Code NLU-5

Weight: 28,924 kg (63,765 lb) Power: ______ W

Type of Experiment(s): 24,660 kg (54,366 lb) of science equipment (see attachments for detailed listing of equipment)

Purpose of Experiment(s): Search of moon origin, geological structure, astronomy, and earth-moon experiments

Type of Sensor(s): X-ray telescope, radio telescope, optical telescope, drill, bio experiment; and video, thermal, chemical, and biological sensors

Unique Sensor Requirements and Technology Status: Deep-drilling equipment to 1,497 m (3,300 ft) and extend lunar surface traverses

Environmental Requirements: Solar flare, micrometeoroid, thermal

Data Processing and Transmission Requirements: 10^6 - 10^7 Hz; storage 10^8 bits; data processing 10^{10} bits/day

Attitude Control and Pointing Accuracy Requirements: ______

Propulsion Requirements: ______

 Code NLU-5

Unique Structural Requirements: IVA repairs and maintenance, drive-in warehouse, both with pumpdown capability for ingress/egress

Environmental Control Requirements: Active system; closed CO_2 and H_2O loop

Guidance and Navigation Requirements: None

Propulsive Requirements: None

Type Propellant: Thrust:

Orbit Adjust: Total Impulse: kg-sec (lb-sec)

Apogee Kick Motor:

Attitude Control: None

Pointing Accuracy: Pointing Direction:

Tracking, Telemetry and Command Requirements: Downlink 10^7 Hz (multi-video)

Antennas: 6 to 8 - 0.3 to 4.3 m (1 to 14 ft), omni/med gain/high gain, S- and X-band

Computers: Yes Commands: 256-512 (16-bit) real time and stored

Type of Electrical Power System: Radioisotope

Average Power: 25 - 30 kW Peak Power:

Unique Interstage/Adapter Requirements: Attachment to lunar lander

SHUTTLE INTERFACE Code NLU-5

Compatibility with Other Spacecraft in Shuttle: Yes X No ___

Access to Spacecraft in Shuttle Required: Prelaunch X Post Launch ___

Support Requirement on Shuttle During Transportation:

Electrical X

Environment ___

Checkout X

Other ___

Visits:

No. of Visits per Year: 4 (logistics)

Payload per Visit: 9,072 -22,680 kg (20,000-50,000 lb) *

Purpose of Visit: Refurbish X Replace X

Maintain X Operate X

Stay Time Required: ___ hr

Requirement for Retrieval: Yes ___ No X Desirable ___

Expected Maintenance Philosophy: Preventive maintenance; fault detection and isolation, servicing,calibration, adjustment, repair, replace, and functionally verify; utilize a monitor/alarm system, spares and tools, and scheduled maintenance priorities and procedures

General comments on gains that can be obtained with Space Shuttle vehicle over expendable launch vehicle: ___

* Details of the logistics are provided in the reference document.

LSB Science Equipment

Item	Weight kg	Weight (lb)
Photographic Astronomical Transit	54	(120)
X-Ray Telescope (Wide Angle)	206	(455)
X-Ray Telescope (Grazing Incidence)	1,617	(3,564)
Radio Telescope (300 kHz - 1000 kHz)	680	(1,500)
Radio Telescope (1000 kHz - 15 mHz)	159	(350)
Optical Telescope (1.3 m)	5,015	(11,055)
Electron Microscope	68	(150)
Antenna Set (0.6 0 1.2 mHz)	200	(440)
Antenna Set (5 - 500 mhz)	45	(100)
RF Noise Survey System - Surface	363	(800)
Dipole Antenna (2 km)	176	(388)
Transponder	58	(128)
Lab (Medical)	2,004	(4,418)
Lab (Data Analysis)	1,361	(3,000)
Lab (Photographic)	680	(1,500)
Lab (Geochemistry)	1,134	(2,500)
Drill (300 m)	9,072	(20,000)
Drill (30 m)	181	(400)
Plant Life Experiment	469	(1,034)
Lunar Cement Equipment	109	(240)
Other	1,009	(2,224)
Total:	24,660	(54,366)

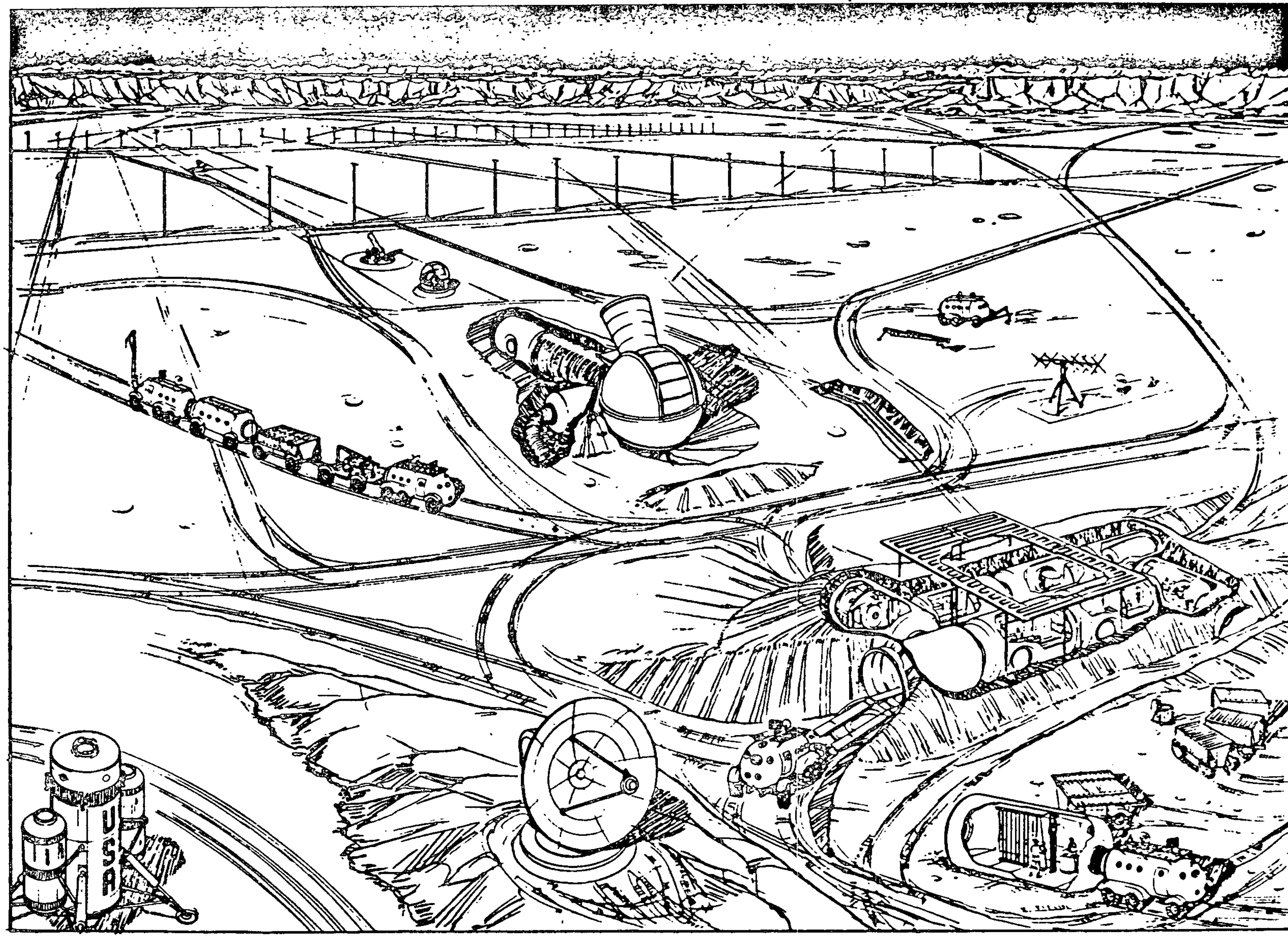
NOTE: Above list includes all LSB science equipment items identified for the total five-year LSB operational period.

Summary Weight Statement, MSS - Derivative Shelter

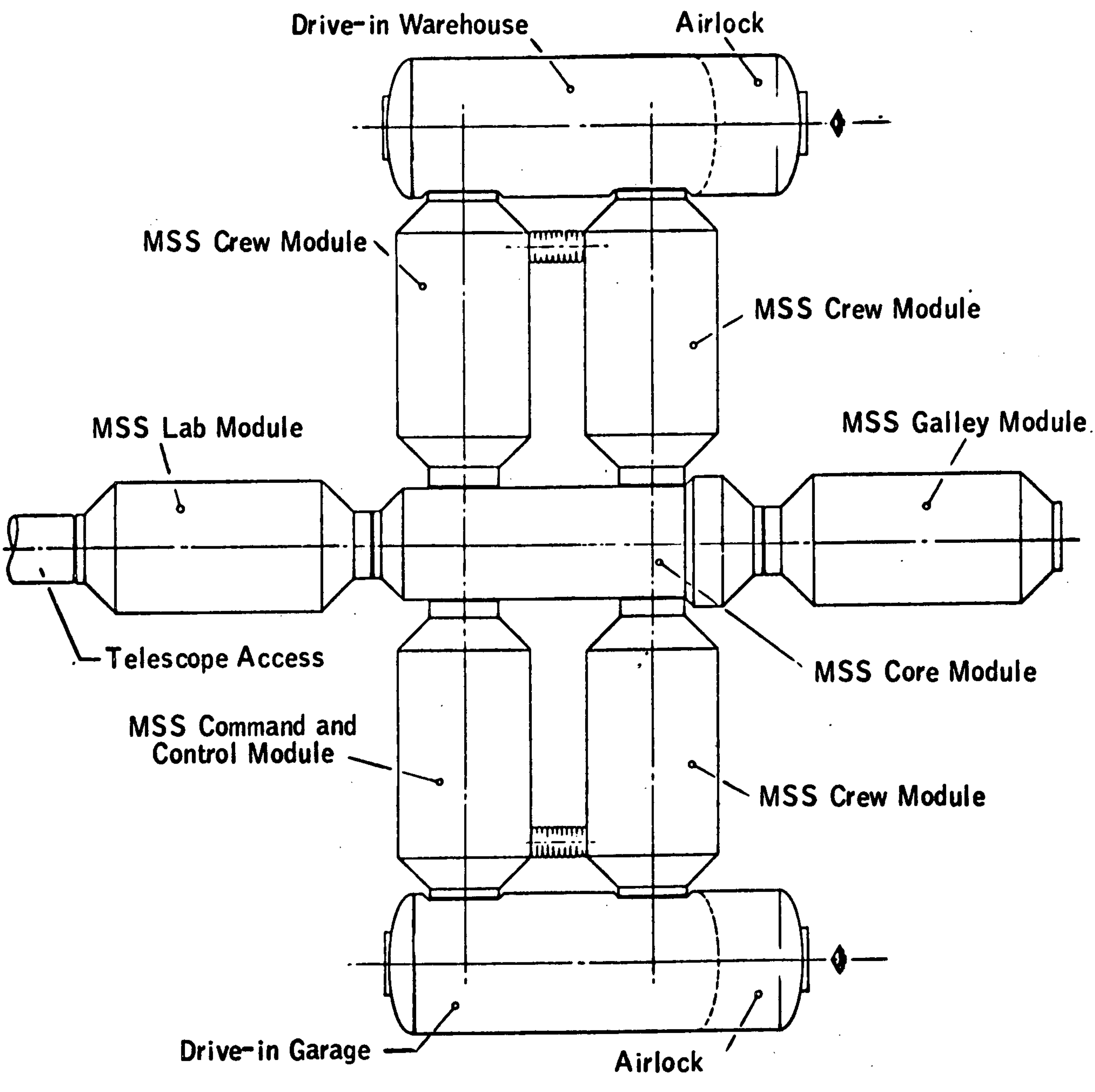
CODE	MODULE	WEIGHT (lb)
CM1	Core Module	9,906
CCM1	Control Center Module (Incl. Labs)	9,852
CCM2	Control Center Module (Incl. Med.)	10,851
CQM1	Crew Quarters Module (Incl. B.U. Galley)	9,914
CQM3	Crew Quarters Module - 4 Man	9,904
CQM3	Crew Quarters Module - 4 Man	9,904
GM	Galley Module	9,728
DWM	Drive-In Warehouse Module	7,330
DGM	Drive-In Garage Module	6,906
	Total - Basic Shelter, 9 Modules	84,295

MSS - Module Weight Summary

	CM1	CCM1	CCM2	CQM1	CQM3	GM	DWM	DGM
Primary structure	5955	3937	4152	4212	4212	3937	5965	6015
Furnishings and secondary structure	1015	1331	1437	1428	1430	1484	541	67
Atmospheric management and crew services	1636	903	1364	3182	3282	2737	558	558
Intercommunications and monitoring	52	93	83	250	240	163	31	31
Electrical power distribution and control	1248	740	740	740	740	740	235	235
Command and control		1290	1390					
Medical facility			750					
Galley				102		662		
Laboratories		1558						
Base maintenance and repair			935					
Total	9906	9852	10,851	9914	9904	9728	7330	6906



Overall LSB Concept



MSS Derivative LSB Shelter

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